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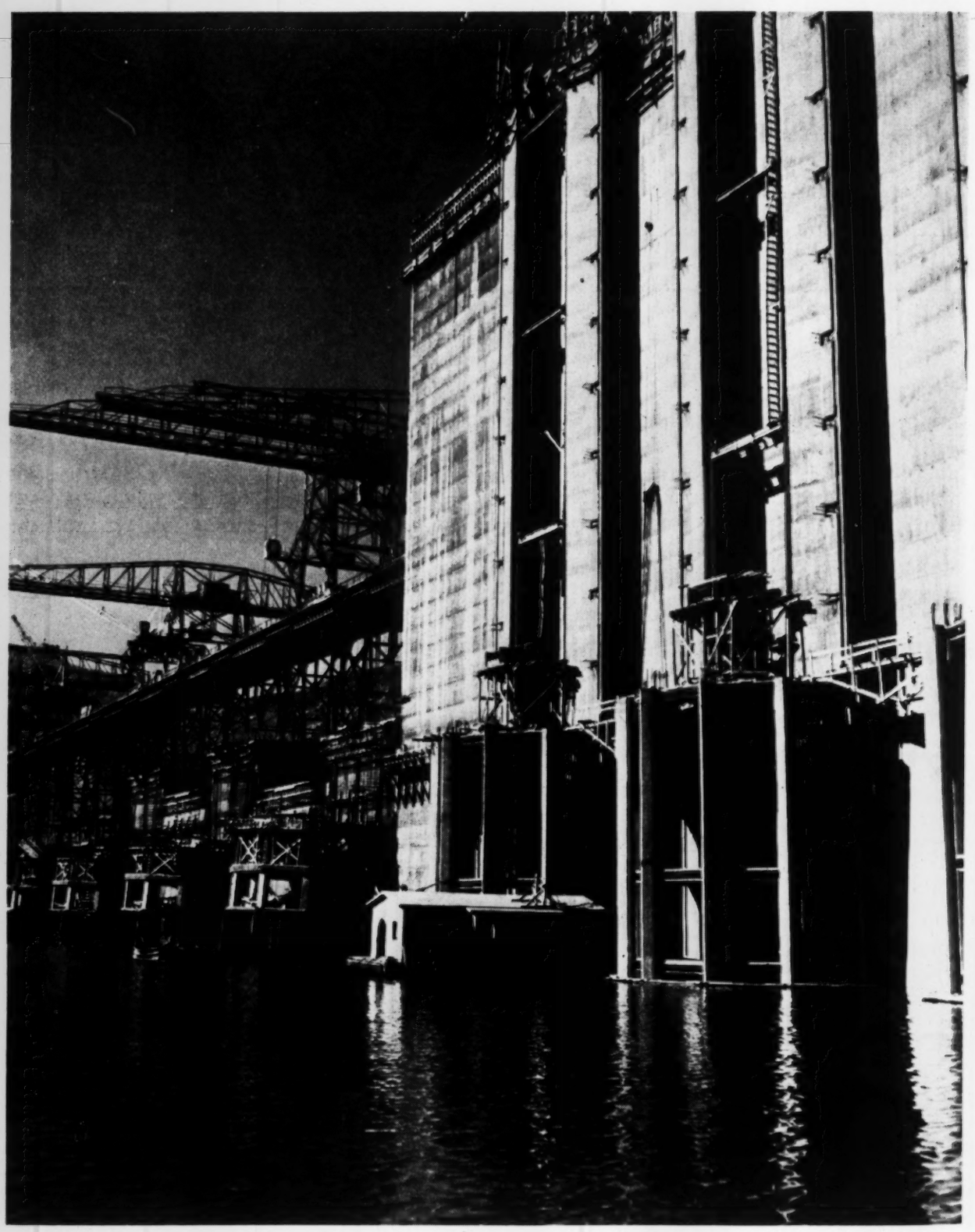

Damming the Columbia River at Grand Coulee

(*An All-Day Excursion to the Dam Is Scheduled for the 1940 Fall Meeting, The American Society of Mechanical Engineers, Spokane, Wash., Sept. 3–6, 1940.* *See pages 628 and 629 of this issue.*)

VOLUME 62
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MECHANICAL ENGINEERING

AUGUST
1940

GEORGE A. STETSON, *Editor*

A.S.M.E. and National Defense

CONGRESS is appropriating billions of dollars for national defense, but it cannot appropriate a single second of time.

To reduce production time is the everyday job of the engineer. He will shortly be called upon to reduce time in carrying out the national-defense program, and it is important, therefore, that he become familiar with it even though it is changing from day to day.

Congress has broken away from the traditional defense policy of the nation by deciding to organize and equip a defense establishment and to lay in stocks of critical materials at a time when the nation itself is not at war. Actions taken have been for the purpose of meeting an emergency. They point, however, to the need for a continuing national-defense policy—something we have never had. This policy must be based on fundamental concepts of relations between the United States and other nations, on the extent to which we will go in supporting this scheme of relations, and particularly on how much we can afford to spend on a continuing program to support it.

Preparation for defense involves major changes in industry. A substantial portion of the nation's manufacturing plants must be diverted from regular production or adapted to the production of noncommercial articles and materials. Changes must also be made in the usual relations of industry to labor, trade, finance, and transportation. In this country there exists no munitions industry with which the nation may deal across the counter for the purchase of modern antiaircraft weapons, tanks, and thousands of other items defense requires. The problem is to adapt existing plants, equipment, and personnel to the production of these items. This takes time—time to place orders, time to design and build the necessary tools and gages, time to train the workmen, and time to train inspectors to become familiar with entirely new products.

The significance of the time element is not fully appreciated by the layman who, in his loyalty to American achievement in industry, finds it easy to believe that the magic of a great name—the name of a man who has been experienced in production—can, overnight, change a plant making automobiles or refrigerators into one making an equal number of aircraft engines. Engineers understand that such a change takes time. Through public discussion and personal contact they can aid tremendously in explaining this fact to lay leaders.

As was the case during the first World War, the production of material for defense requires the ability of the engineer in the design of product and tools and in the development of production methods that will be time-saving and economical. Modern warfare with its extensive mechanization is essentially a conflict between the productive capacity of nations. This too the public needs to understand.

It is reassuring that the nation is facing the defense problem better prepared than it was in 1917. Today, with but few exceptions, the types of equipment needed by the Army and Navy have been adopted. Plans for procurement of critical and essential items have been made. Qualified industrial plants have been selected for the manufacture of this equipment. Many of these plants have already produced some of the items. Others have undertaken to execute educational orders to familiarize themselves with the use of tools, gages, and inspection requirements of the new products. Still others have made production studies on specific items of material and are well on their way to becoming familiar with a new product to be manufactured. The Army and Navy are cooperating closely in procurement activities. Accurate information is available regarding the critical materials that are needed. But there is much to be done. Supplies of critical materials must be secured. Orders must be placed for the products. New construction must be provided and plans developed for the training of men. All these are under way. Again, time is all-important.

The National Defense Council of Cabinet members has been created and an Advisory Commission of leaders in the industrial and business worlds has been mobilized to aid. This commission is not setting up new agencies but is acting to smooth the paths of the regular procuring agencies of the War and Navy departments.

Scores of A.S.M.E. members have written, telephoned, and called in person at the Society headquarters to offer their services and experience in the emergency. To them may we counsel patience. Qualified men in great numbers will be needed and the Society will use its facilities in aid of those who would serve and in aid of the defense arms in selecting the right men for specific problems.

Already The American Society of Mechanical Engineers has given careful thought to the service it and its members can usefully render. Since the last war it has consistently argued for adequate industrial preparedness. Addresses at meetings and discussions in the publications have emphasized the importance of a continuing policy of preparedness in the productive capacity of industry in the event of emergency. In a quiet unofficial way the A.S.M.E. has made available small study groups for particular problems of the defense services.

Right now there are four useful functions that the

A.S.M.E. can perform in the interest of national defense. Forums of the Society and of the sections can be made available for the discussion of problems of national defense. Qualifications of the individual members of the Society can be made available to the defense arms of the government and to industry so that the proper men can be selected for the solution of many new and diverse problems that grow out of the national-defense program. Groups of experts can be selected for the study of particular technical problems. Finally, the Society may express sound engineering views on the relation of standardization, research, and education to the defense program.

With these opportunities in mind the A.S.M.E. Council has placed the services of the Society at the disposal of the defense arms of the government. The Committee on National Defense has been enlarged. Immediate plans are under way for early discussion of technical problems of national defense at Society meetings. The Society has taken part in a census of engineers qualified to serve in an emergency construction program and, as the needs are more clearly seen, will aid in a census of its members available for design, research, and production.

Your Committee on National Defense has already consulted with officers of the defense arms and members of the Advisory Commission of the National Defense Council. For the moment the Committee has a direct message to industry and to individual members of the Society. That message is: Remember the time element! Be patient. Give the defense arms of the government the necessary opportunity to translate the increased tempo and enlarged scale of defense needs into procurement orders which will be forthcoming as soon as humanly possible. Keep away from Washington and give those who have work to do a chance to do it. The national program of defense production is in good hands. Its initiation on a large scale is now under way.

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Applied Mechanics Expands

FEW developments within The American Society of Mechanical Engineers during recent years have been as gratifying as that of the Applied Mechanics Division. Headed by a group of able, loyal, and enthusiastic men, the Division has made a name for itself internationally as well as nationally by the contributions it has made to the literature of the field of engineering which it represents. The *Journal of Applied Mechanics* is known today wherever serious efforts are made in the analytical and experimental study of problems relating to this field.

What prompted the papers and what practical results have flowed from them would be a fascinating story that would convince even the most hardened skeptic of the value of the work of the Division of Applied Mechanics and the *Journal*. If this story could be properly told, financial support for the division and the *Journal* would be readily forthcoming. At present a contribution to the *Journal* is made from the budget of the A.S.M.E. Transactions, of which the papers in the *Journal* form a part, and from donations to the Society for the use of the *Journal* by its friends in a few university and industrial laboratories. For several years both the Division and the A.S.M.E. Committee on Publications have been seeking means by which the *Journal* may be expanded and by which the apparent waste of distributing copies to every member of the Society, regardless of his interest in and need for the subject matter, may be avoided. Such a means is believed to have been found, and its adoption by the Society was recommended to the Council at the meeting in Milwaukee, as reported on page 636.

As will be noted in the report of the Council action referred to, adoption of the proposed plan is contingent on the results of a letter ballot that has been sent to the more than 3000 members of the Society who have expressed interest in the work of the division. It is to be noted that this number represents nearly one quarter of the entire Society membership. Hence the result of the ballot should be representative of the opinions with regard to the desirability of the plan of a majority of members.

The plan proposes to reduce the actual contribution from Transactions funds and the cost of publishing the *Journal* by sending it only to members willing to subscribe a nominal annual fee of one dollar for its support. According to estimates, the plan should make possible a greater volume of material published and bimonthly publication. Because members not interested in the papers published in the *Journal* are being asked to give up four issues per year that they may not now use, and because of the savings possible under the proposed plan (nearly $3000) will be added to the fund available for publishing the Transactions in which the papers of the Society's other divisions are issued, this *quid pro quo* is the element of the plan that has, in the minds of the Council and the Committee on Publications, made it seem fair to all concerned. If there is any apparent unfairness it is to the members of the Applied Mechanics Division, and some have protested against the charge of one dollar for the *Journal*. It must be remembered, however, that it would be much less fair to ask nonsubscribers to the *Journal* to contribute as much out of their dues as they now do, and get nothing in return for it.

Final results of the ballot, on which adoption of the new plan depends, are not yet complete. The purpose of this explanation of the plan is to make public what seems to be the justification of the proposal which had its origin in the Division itself. If the plan is adopted as a result of favorable balloting, it will be put into effect as of Jan. 1, 1941, and the Transactions, increased in volume, will also be issued bimonthly, alternating with the *Journal* in order to save money and avoid peak loads in the editorial department and at the publishing house.

DESIGN *of* HYDRAULIC MACHINERY *for* MODERN PRODUCTION DEMANDS

By RAYNAL W. ANDREWS, JR.

ALUMINUM COMPANY OF AMERICA, PITTSBURGH, PA.

THE selection and design of a hydraulic machine are inseparably related to the hydraulic service system. In broad terms, hydraulic service systems can be classified as either the direct-pumping or the accumulator type. Practically all self-contained presses powered with variable-delivery pumps fall into the direct-pumping class, as do some forging presses, steam platen presses, sheathing presses, and other types which are serviced directly by piston pumps, centrifugal pumps, intensifiers, or other power pumping devices. Since it is manifestly impossible to discuss all of these various types of hydraulic machines and their uses, this paper is confined to certain salient features common to all forms of modern hydraulic machinery.

The duty cycle of the machine and the economics of the particular application will dictate the hydraulic service system to be selected. These will, by implication, also dictate the fundamental basis of the design. The economics of each individual problem must be considered in the light of the particular conditions which exist. Engineering analysis, however, will usually point the way to the most efficient and economical solution. It is this point which is frequently overlooked by the enthusiastic advocates of one system or another.

ECONOMIC CONSIDERATIONS OF SELECTION

"Instantaneous horsepower," so-called, which is a most useful yardstick, is really the horsepower required for a very short period of time during the most rapid portion of the duty cycle. It presents a problem of maximum velocity at high pressure and not one of averages.

In the direct-pumping system it is apparent that the press cannot move faster than the pump will deliver the working fluid. Direct-connected systems seldom attain 1000 hp and rarely exceed that value. This, of course, is connected and not continuously developed horsepower.

Centrifugal pumps have not as yet found wide use in power hydraulics principally because they have not, until the last few years, been developed for the pressures usually encountered in hydraulic-press systems. They are inherently machines of lower efficiency than the more common types of pumps. These high-pressure pumps are of the multistage variety, frequently having from 20 to 60 stages. The maximum pressure seldom exceeds 3000 psi.

Self-contained presses usually operate at or below 2500 psi. Manufacturers of variable-delivery pumps do not often recommend their equipment for working pressures in excess of this value although there are a few installations of experimental character operating at somewhat higher pressures. The most suitable field for the self-contained press is that in which moderate values of instantaneous horsepower are indicated. The reason for this is probably the fact that the control advantage inherent in this type of system is lost when multiple high-pressure pumps are required to feed into the same high-pressure service line.

These limiting conditions, then, indicate the engineering approach to the problem of selecting the proper hydraulic service system. Consider, for example, a 2000-ton self-contained press, for the forming of sheet parts for aircraft use, serviced by a variable-delivery pump, and powered with a 100-hp motor. The normal speed of this unit at rated load is 9.9 in. per min. At this speed the instantaneous horsepower value is 100 hp, a reasonable condition for a self-contained press.

In contrast, a 2000-ton hydraulic forging press may be analyzed. For this duty, a rate of 60 one-inch strokes per minute, or one complete cycle per second, is not unusual. In years past, a rate of 30 one-inch planishing strokes was considered normal, but today there are forging presses in operation at rates as great as 120 strokes per minute. If we presuppose a dwell of two tenths of a second at each top and bottom position, it is reasonable to assume a pressing stroke of one inch in four tenths of a second, or a maximum rate of 150 in. a minute. On this basis the instantaneous horsepower is 1515 hp.

It is necessary also to consider the "overperiod" water rate or average gallons per minute required. From this we can obtain the average horsepower, which is the horsepower required when an accumulator system is used. We find that 257 gpm is required if a working pressure of 5000 psi is assumed. The theoretical water horsepower required is 753 hp, provided an accumulator is used to deliver working fluid at the maximum rate required.

It is apparent that each type of service system has its place and that no single type can be considered as the most modern or the most efficient for all applications. The hydraulic service system will be dictated by the press capacity and duty cycle, and the design of the press will be influenced accordingly.

It is frequently desirable to manipulate a hydraulic press at high speed during an idle stroke. This can be done at low pressure in order to conserve power and reduce the capacity of the high-pressure system. It is usually accomplished by prefilling the main cylinder of the press with low-pressure fluid from an air-ballasted prefill tank, or by using a small manipulating cylinder to move the main press ram. In the latter case, the main cylinder is usually filled by gravity, although for extremely high-speed operation a pressure prefill may be necessary to prevent cavitation or incomplete filling.

Self-contained presses of smaller tonnage ordinarily prefill with a high-delivery low-pressure pump. Presses of larger tonnage are provided with an air-ballasted prefill. In this

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latter system, pressure is maintained by returning the working fluid through the prefill tank against a cushion of air. The prefill tank is provided with a sensitive overflow valve which permits working fluid in excess of the prefill volume to return to the pump suction tank. The sensitivity and reliability of this overflow valve are of paramount importance in maintaining the prefill pressure at the predetermined value. The valve must be of adequate area to prevent excessive pressure rise when the working fluid is returned at high velocity. Good practice requires that fluid velocities be held below 20 fps.

When the prefill system is used only for the idle manipulation of the main press ram, the volume of residual air and the consequent pressure drop are not of great moment. In certain press applications, however, preliminary and supplementary operations are, for the sake of operating efficiency, performed with low-pressure fluid. When this is the case, the ratio of the volume of residual air to the maximum drawdown volume becomes a factor of real importance. The permissible pressure drop will depend upon the duty; but it can be said in general terms that pressure drop should be limited to 10 to 20 per cent.

DESIGN OF HYDRAULIC-PRESS CYLINDERS

The basic design of any hydraulic press revolves about the design of the press cylinders. In hydraulic-press practice these cylinders invariably fall into the category of thick-walled cylinders in which it is recognized that the maximum stress occurs as tangential or "hoop tension" stress and that, with internal pressure applied, the unit stress varies through the cross section from a maximum value at the inner bore and decreases in a sharply curved path to a minimum at the outer surface. This relation may be seen in Fig. 1.

The line of demarcation between thick-walled cylinders and thin-walled cylinders has not been clearly defined. The API-ASME Code for Unfired Pressure Vessels recognizes a thick-walled cylinder as one in which the ratio of inside diameter to wall thickness is less than 10. This may be seen in Fig. 2. There are a number of formulas for calculating the strength of thick-walled vessels. All of these originate from the same differential equation which was postulated by Saint Venant, but they differ from one another in the coefficients used. In the

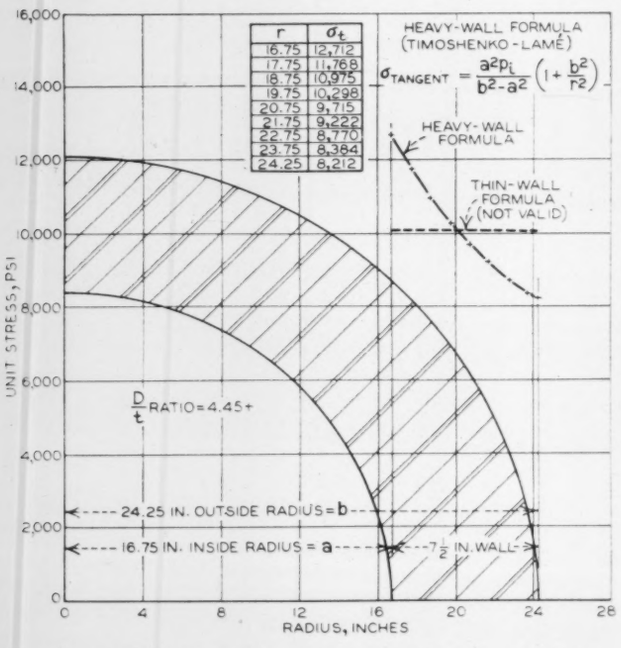


FIG. 1 HYDRAULIC CYLINDER TANGENTIAL STRESS AT 4500 PSI

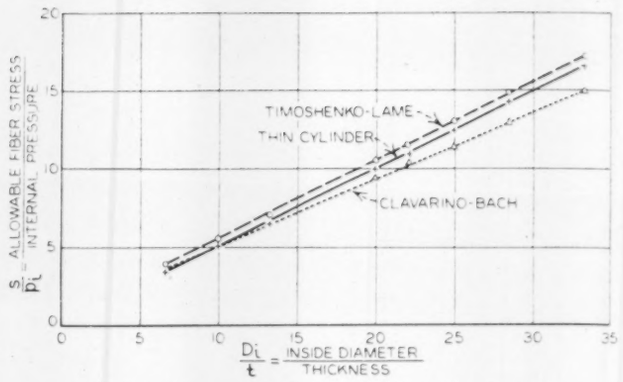

$\frac{S_i}{p_i}$ = ALLOWABLE FIBER STRESS / INTERNAL PRESSURE
TIMOSHENKO-LAMÉ-THIN CYLINDER
CLAVARINO-BACH
$\frac{D_i}{t}$ = INSIDE DIAMETER / THICKNESS

FIG. 2 WALL THICKNESS OF CYLINDRICAL VESSELS

United States the versions of Lamé and Timoshenko are commonly used. Lamé's version is used by the War Department in the calculation of stresses in gun tubes. Fig. 2 also shows the curve on the Bach formula which is in general use within Continental Europe.

All of these formulas assume that the cylinder can expand freely without restraint and that the wall is of uniform thickness throughout, without lugs, ribs, and stiffeners. It has been common practice in the hydraulic industry for many years, however, to design the main cylinder, the pullback cylinder supports, and the upper or rear platen as an integral casting. Frequently these cylinders have been designed with sharp changes in cross-sectional area and small fillets which have made the casting difficult for the foundryman and have resulted in inherent casting strains. More recently greater attention has been given to the design of these castings from the foundryman's point of view. More generous fillets have been specified as the occurrence of stress concentrations has been recognized. Normalizing and stress-relieving heat-treatments have become common practice.

Basic cylinder design, however, has not changed. It is doubtful if any attempt is ever made to analyze the true stresses which occur in these composite cylinder and platen units. Such an analysis is so difficult as practically to defy the efforts of the most accomplished masters of stress analysis. The designer of a composite unit has thus committed one of engineering's most unforgivable sins. He has forgotten the basic assumption with which he started, namely, that the cylinder is free to expand without restraint.

Some designers have based each succeeding design upon those that have preceded it, invariably adding a little more material here or there. They have failed to realize that there are occasions where the addition of material may actually weaken a structure, either by causing the loading of various components to become eccentric and thereby inducing unanticipated bending moments, or by restraining the free movement of those components when stressed and thereby inducing secondary bending stresses, often of great magnitude.

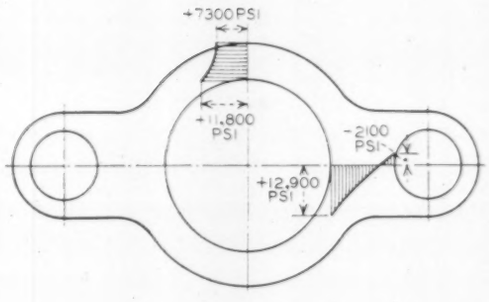
To study this problem, a series of strain measurements was made of a hydraulic cylinder of cast construction of unimpeachable foundry design. This cylinder was constructed with two diametrically opposed integrally cast lugs for the support of two pullback cylinders. A cross section of this cylinder is shown in Fig. 3.

These careful measurements under conditions of no stress were compared with the same readings taken at maximum stress. It can be seen from Fig. 4 that the cylinder, if unrestrained, would have deflected uniformly in a radial direction; actually it assumed an elliptical shape because of the stiffening effect of the lugs.

Computing the stresses from strains measured on the outside

of the cylinder, it becomes clear that the tangential stress, normally a maximum at the bore, becomes a maximum in the bore at the center of the lugs, at the ends of the minor axis of the ellipse into which the cylinder deforms under load. The computed stressdistribution at the ends of the principal axes of the ellipse is shown graphically in Fig. 5. Had the thickness of the lugs been greater, and the lugs stiffer, the maximum stress would have been even greater than the curves indicate. The significance of these tests is not particularly in the specific values obtained, but in the general behavior of stressed cylinders which the tests have disclosed.

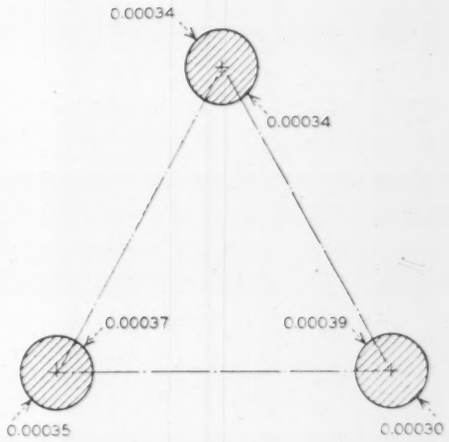
The effect of change in section and change of direction in a structure is shown in Fig. 6. In spite of the fact that a generous fillet has been used between the cylinder wall and the lug, it will be seen that the stress increased 20 per cent at the change of section. Since so gradual a curve produces a stress-concentration factor of 1.2, it can be readily seen that the stress-concentration factor would increase rapidly with a more abrupt change in section. While this observation was made on a hydraulic cylinder, the result is equally applicable to other structural members.



POINT	STRAIN, IN. PER IN.	STRESS, PSI
A	0.00013	+4500
B	0.00016	+5400
C	-0.00001	-300

FIG. 5 STRESS DISTRIBUTION IN HYDRAULIC CYLINDER

FIG. 6 EFFECT OF CHANGE IN SECTION OF HYDRAULIC CYLINDER



ROD	PER CENT PRESS TONNAGE
A	29.1
B	30.7
C	29.4
FRICTION	10.8

FIG. 7 UNEQUAL STRAINS IN CAREFULLY INSTALLED THREE-COLUMN HYDRAULIC-PRESS STRAIN COLUMNS

ALIGNMENT OF MOVING PARTS

In the last few years increasing emphasis has been placed upon the maintenance of accurate alignment and parallelism of the moving parts of the press under conditions of either central or eccentric loading. This feature is of prime importance for normal industrial applications, but it has received particular consideration in recent months in connection with shell presses wherein accurate alignment of the punch is of paramount importance. The trend has been toward a housing type of press with the movable crosshead guided in long gibs or ways, principally because of the fact that the housings provide additional lateral stiffness. The sliding surfaces must be carefully designed and should be provided with suitable wipers so that particles of dirt and scale which are blown from the dies or which fall onto the ways will not score and damage them. A modern gib-guided forging press is illustrated in Fig. 8. Some manufacturers have considered this disadvantage sufficiently valid to retain and improve the older practice of column guiding. They have resorted to accurately ground columns with fitted guides spaced at some distance apart to provide an adequate resisting moment arm and to reduce the normal forces on the bearing surfaces. These guides are fitted with oil seals on the top and bottom and are completely filled with lubricating oil. In some cases the exposed portions of the columns are covered with canvas boots.

The solution of this problem must be arrived at in each individual case after analyzing and evaluating the factors involved. It must be recognized, however, that the failure to give adequate consideration to this feature in the design of hydraulic-press equipment in the past has resulted not only in production difficulties but also in the expensive structural failure of components of the press from secondary or induced stresses, not considered by the designer, which should not have been permitted to exist.

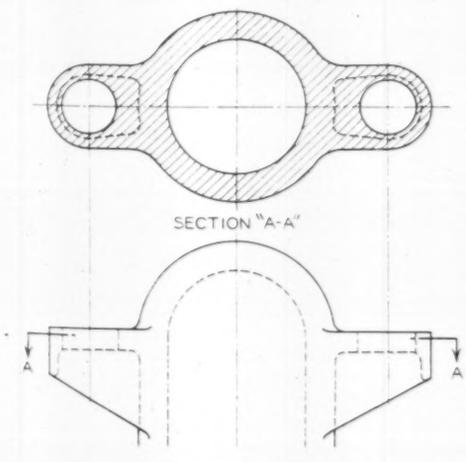
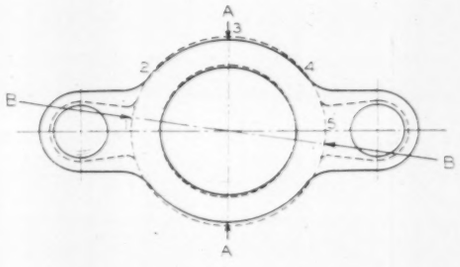


FIG. 3 HYDRAULIC CYLINDER CAST FOR TESTING



POINT	STRAIN, IN. PER IN.	STRESS, PSI
1	0.00024	7900
2	0.00025	8500
3	0.00022	7600
4	0.00021	7300
5	0.00024	7900

INCREASE IN DIAM UNDER LOAD
AA - 0.0132 IN.
BB - 0.0116 IN.

FIG. 4 STRESS-STRAIN MEASUREMENTS ON HYDRAULIC CYLINDER

In either the housing or the column type of press, the upper or rear platen supporting or containing the main cylinder, and the lower or front platen, depending upon the disposition of the machine in a vertical or horizontal position, are held in relation to each other against the load of the press by large strain rods or columns. In some cases these two platens are retained in a parallel relation to each other by the adjustment of the column nuts. In other designs, spacers, housings, or shouldered rods of equal length are used. As long as absolute parallelism is maintained, the strain rods evenly distribute the load, which manifests itself as a uniformly distributed stress across the cross section of each rod. If absolute parallelism is not maintained, a moment is established which results in unequal division of stress among the several strain rods and a nonuniform distribution of stress within each rod. One or more of the strain rods is inevitably stressed beyond the design value and the record of failures among users of hydraulic machinery serves to verify this contention. Another study conducted on a well-designed and carefully installed three-column press serves to point this out. Fig. 7 shows that the strain in two of the three strain rods or columns is not the same on opposite sides of the same rod. No two rods carry exactly the same load, indicating clearly the existence of some misalignment and the existence of a moment. It is estimated that the two platens are not off parallel by more than one or two thousandths of an inch. Had the misalignment been greater, the observed differences and the corresponding inequality of stresses would have been much greater.

This misalignment, however, is reflected in the stresses transmitted to the platens and, in some cases, the base plate or the foundation. These moments set up by misalignment must be counterbalanced by resisting moments which introduce in the platens stresses and strains which are not contemplated by the designer.

In presses where housings or spacers are used, it is customary to prestress the strain rods or columns in order to prevent a loose articulation of press components when the press is under substantially maximum load. This is sometimes done by jacking and shimming, but where this is done the total force exerted by the jacks must be somewhat in excess of the net force to be exerted by the press. In other cases the rods are heated with torches or by means of steam. When torches are used, great care must be taken to heat the strain rods uniformly to obtain uniform thermal expansion around their peripheries at all sections and to heat all rods to the same temperature to secure the same amount of expansion and subsequent shrinkage in each rod. Variations in the amount of shrinkage will result in variations in strain in the spacing members and will produce slight but permanent misalignment.

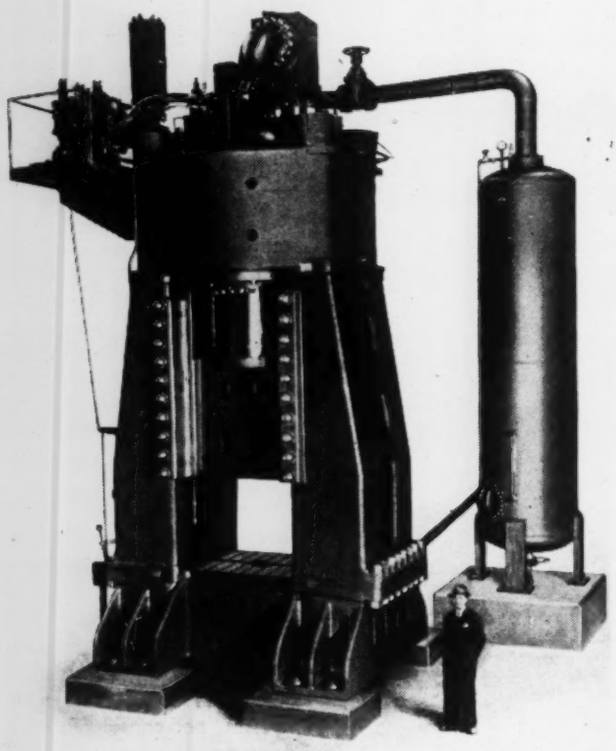


FIG. 8 GIB-GUIDED HYDRAULIC FORGING PRESS

DIFFERENTIAL THERMAL EXPANSION

This discussion would not be complete without at least passing mention of the problem of differential thermal expansion so frequently present in the design of hydraulic machinery and so often ignored or inadequately disposed of by the designer. Particularly evident in the working of metals on hydraulic presses is the fact that the working end of the press is hot and the hydraulic power end relatively cold. Here, again, is a condition through which unrecognized secondary stress effects find their way into press performance, frequently with expensive and disastrous results.

PROBLEM OF CONTROL

The most critical feature in the design of a hydraulic press for modern requirements is that of control. The development of new ferrous and nonferrous alloys, plastics, and other materials has created the need for a predetermined high-speed cycle of operation and a precision of speed control never before attained. These specifications have placed heavy demands upon the ingenuity of the designer and have been a constant prod to the raw-material supplier to produce better materials.

Basically, this control can be accomplished either by varying the rate with which the working fluid is pumped to the press or by introducing a variable restriction through which to regulate the rate of flow from an extremely large source of pressure fluid. The stipulation must be added that, whatever device is used to accomplish this control, both the time and the physical effort required must be held to the barest minimum.

The variable-delivery pump of either the rotary or the plunger type affords the first of these methods of control. In either case the stroke of the pump is varied by mechanical means. It is conceivable that this might also be accomplished in a fixed-stroke pump by varying the speed of the prime mover as is frequently done with steam pumps on curing presses. The steam or pneumatic intensifier functions essentially as a variable-delivery pump obtaining its variable characteristic from the regulation of its prime mover. For purposes of analysis these may all be classified together.

The major problem connected with control by regulation of pump delivery is that introduced by the inertia of the mechanical parts of the pump or the prime mover as the case may be. From this it is apparent that the pump design and materials must be of such a nature as to reduce the mass of these parts to the minimum consistent with strength and safety. Examining this problem from the viewpoint of Newton's laws of motion it is evident that for a given rate of change of pump stroke the force required is directly proportional to the weight moved, and if that given weight is to be shifted more rapidly the force required increases in inverse proportion to the square of the time interval. This is the inherent limitation of the scheme of control by variable delivery. A clear understanding of this point will define the field within which this excellent device is of practical value.

Some hydraulic systems are serviced by direct pumping from one or more fixed-stroke positive-displacement pumps. Here, obviously, there is no control, for the rate of advance of the press ram is a function of the pumping capacity. In these systems it is customary to pump directly, limiting the pressure by by-passing through a relief valve preset for the maximum pressure. Even though an auxiliary pump by-pass valve is ordinarily used to cause the pump to circulate pressure fluid at practically no pressure, this relief valve is a source of many shocks and pressure surges frequently of unmeasurable duration and alarming magnitude which result in expensive maintenance. A compromise solution can be found by manipulating a pump unloading device which holds open the pump suction valves, but this has the disadvantage of requiring time to load and unload each pump which may or may not be an appreciable factor, depending on the character of the duty cycles. Here the high-pressure centrifugal pump can be used to advantage, the principal drawback being the necessity for a partial by-pass at shutoff head to prevent the overheating of the working fluid.

Presses of large capacity or rapid-duty cycle which are serviced from an accumulator system must be controlled by throttling. This is done by providing a means of varying the area of an orifice or several orifices in the main press service line. This throttling represents the loss of energy which evidences itself as frictional heat. The heat usually can be dissipated by conduction and radiation but sometimes must be removed in a heat exchanger. It would seem at first glance as though this scheme of control would be most inefficient but the fact remains that no better alternate has ever been devised. In press designs in which control by throttling is indicated, the loss of energy due to throttling must be accepted as an inherent disadvantage and attention given to ways and means of minimizing the mechanical maintenance of the throttling device.

Throttling involves the conversion of pressure energy to velocity across the restricted area of the throttling device and this very high-velocity fluid has a scouring or wire-drawing effect upon the throttling surfaces. Oil as a working fluid has less eroding influence than has water.

Throttle valves are, essentially, variable submerged orifices. As such, the velocity through them can be determined easily by the use of the submerged-orifice formula $V = C_d\sqrt{2g(h_1 - h_2)}$ and the discharge computed by combining it with the equation of continuity, with the resulting equation $Q = AC_d\sqrt{2g(h_1 - h_2)}$. Practically, they are constructed either as a balanced or unbalanced globe or poppet valve with a conical seat, or as a sleeve valve wherein the sleeve is perforated with a number of ports of small area which are progressively uncovered as the valve is opened. These ports may be round or contoured to increase in area with increased opening. The characteristics of the valve at various openings may be predetermined by the design and orientation of these ports. Since, in a throttle valve, maintenance and simplicity of replacement of parts must be a prime consideration, many consider the more satisfactory type to be that in which a poppet or plug is used to arrest flow completely and in which throttling is accomplished by causing the plug to uncover orifices or slots so proportioned as always to limit the velocity of flow across the seat of the valve.

It is evident that materials play as important a part as design. While it is evident that dissimilar materials should be used wherever two or more parts must have relative motion, these materials should be heat-treated to as hard a condition as can be obtained, consistent with strength and ductility. Hardness values of 500 Brinell and harder are not unusual. Some of the heat-treatable steels in the "stainless" family have found great favor for this service.

Careful design and selection of operating valves are equally important. It must be recognized that during opening and closing, all hydraulic valves are subject to the same deleterious effect of high-velocity fluid as are throttle valves. For this reason, and for the even more important reason of minimizing hydraulic shock, these operating valves must be designed of such a net area as to limit the fluid velocities through them. There is a marked difference of opinion among contemporary designers as to the correct value for limiting valve velocities. One manufacturer uses the conservative value of 20 fps. Velocities up to 40 or 50 fps can be used with safety although lower velocities are desirable.

This problem of limiting the fluid velocity through a hydraulic valve is one which has not been given the consideration it merits. One reason for this is the fact that the so-called balanced hydraulic valve of the spool or poppet type is not in complete hydraulic balance, and the degree of unbalance increases with the size so that the physical effort required to operate it manually approaches the limit of human strength. The other primary reason is that these valves have frequently been improperly used for at least partial throttling control. Since it is a recognized fact that control cannot be attained without high velocities, valves of inadequate area have been improperly specified. In either case the result has been the same—high maintenance, leakage, and the production of severe hydraulic shocks which, in some cases, have resulted in structural failures of cylinders, pipes, or valves.

Severe hydraulic shocks are also frequently observed when the working fluid is released from the pressure cylinder; this is caused by the elastic strains in the stressed cylinder which, when relieved, cause a return pumping action as the cylinder returns to its unstressed configuration. This fact has given rise to the use of pressure-break valves of smaller area than the main operating valves which permit the release of the stored energy without shock. They act in effect like orifices and are sometimes supplemented with orifices. In either case they provide the means of energy dissipation necessary to avoid hydraulic shocks of noticeable proportions. Large valves with smaller integral pressure-break spindles are frequently used also to provide better hydraulic balance and to obtain better control than is obtainable with valves of the conventional type.

There is no phase of press design more in need of study and the application of inventive genius than that of valving and control. Second only to this in importance is the problem of valve materials. The trend is definitely toward harder tougher materials and with this a high degree of precision and accuracy in the requisite machine work.

The trend likewise is toward flanged hydraulic connections of adequate strength, and to press connections and pipe lines of sufficient area to limit line velocities to 10 fps or less. It is regrettable that the power-piping standardization committees have not yet been able to expand their activities into the range of pressures usually employed for hydraulic machinery. It is necessary then to apply correctly the principles of mechanics of materials and to follow this procedure for each individual application. Use of the methods outlined in the API-ASME Code for Unfired Pressure Vessels offers a source for a tentative standard.

Looking in perspective at the design of modern hydraulic machinery, it becomes apparent that the trend is toward more rational engineering analysis and less trade mystery, the more efficient use of structural materials, and the use of superior materials as technical progress is made. The improvements in the art all represent an increase in initial capital outlay; but, because of the improvement in rate of production and continuity of service and the reduction of maintenance, the modern hydraulic machine appears to be a most attractive investment.

DYEING *and* FINISHING FABRICS *Containing* RAYON-STAPLE FIBERS

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THE manufacturer and seller of rayon, whose products go to many different mills and usually pass through several hands and several stages of fabrication between the time they leave the factory and the time they enter the dyeing-and-finishing plant, cannot acquire an up-to-date, comprehensive knowledge of the handling of the many types of spun-rayon fabrics in the finishing operations. His contacts enable him gradually to accumulate information based on practical experience, but much of this is necessarily confidential in nature and, in justice to those plants which have been opened to him, only the general principles which can be deduced from this assortment of individual experiences can be discussed.

In view of the fact that the use of rayon staples on an extensive scale is comparatively recent, the finishing industry is undoubtedly far better informed as to their behavior than the rayon manufacturer himself. For detailed information on the procedures which are being used in handling rayon staples in stock, top, and yarn forms, as well as in fabrics made wholly or in part of rayon staple, the reader is referred to several recent papers (1, 2, 3).[1]

Rather than attempt to duplicate or even to abstract these publications, the present paper undertakes to point out the distinctive characteristics of the two types of rayon staple produced commercially in the United States in comparison with the corresponding characteristics of wool and cotton so that the dyer and finisher himself may apply this fundamental knowledge of fiber properties and behavior to his own techniques of wet- and dry-processing, in order to produce the effects desired.

COMMERCIAL CHARACTERISTICS OF RAYON STAPLES

From the viewpoint of commercial characteristics, rayon staples are classified as to type, luster, length, and fineness. There are two distinct types of rayon staple, namely, viscose-rayon staple and cellulose-acetate- or simply acetate-rayon staple. The properties of viscose staple and of acetate staple are as different as those of the corresponding filament yarns because of the fact that viscose is cellulose, whereas, acetate is a chemical compound formed from cellulose and acetic acid.

Both of these types are available in bright and in dull luster. The dull luster is obtained by the addition of a small amount of titanium-oxide pigment to the spinning solution and is, therefore, not a surface effect, but is inherent in the fiber structure. Black staple of extremely good fastness to all conditions is also obtainable.

Most of the viscose-rayon staple manufactured in, or imported into, the United States is of the normal type. A number of special varieties have been made in other countries including viscose-rayon staples with affinity for wool dyes, having a rough surface and with curl or crimp. In time, such special varieties may assume greater importance here.

The first acetate staples developed were of the ordinary or straight variety, but the recent expansion in the use of acetate staple in the United States has been due to the development, in this type, of an inherent crimp or waviness in simulation of the crimp in wool.

Rayon staples may be cut to any desired length. Usual commercial lengths are correlated to the most commonly used lengths of the natural fibers. Whereas, production of longer fibers of cotton is a painstaking problem of breeding and cultivation with an upper limit represented by the rare Sea Island variety, the staple length of which runs up to 2 in., and by the more available Egyptian cottons such as Sakel, Giga, and Maarad, in which staple lengths average $1^1/_4$ to $1^1/_2$ in., rayon staple for the cotton system can be produced as easily and as cheaply in lengths of 2, $2^1/_2$, or 3 in. as it can in lengths of 1 or $1^1/_2$ in. This is causing a strong trend toward rebuilding cotton spindles to handle these longer staple lengths and is markedly influencing the design of new machinery of the cotton type which will be used to make stronger, finer yarns from these longer rayon staples. The same reasoning holds true for other systems of spinning, although the development has not yet advanced so far. The worsted spinner is limited by the fact that the finer wools are shorter in length than the coarser varieties. In the rayon staples, however, he can select a fineness equivalent to a fine wool and obtain it in the longest fiber length which his machinery can handle.

With respect to fineness, rayon staples are designated by denier, a scale of fineness measurement which has been inherited by the rayon manufacturer from the silk industry and which he has carried over from the continuous-filament yarns to the staple fibers.

Viscose- and acetate-staple fibers are both available in a variety of finenesses ranging from 1.5 denier, corresponding to fine cotton on the one hand, to 20 denier, corresponding to carpet wool and very coarse mohair, on the other. An especially strong viscose staple is made in 1.25 denier. Therefore, the fabric designer can select the fineness of his rayon staple according to the softness, crispness, or harshness desired in the finished fabric. He must remember, however, that the rayon staples are far more uniform in diameter from fiber to fiber than the natural fibers and must, therefore, often blend several different deniers to simulate the effect obtained with a single quality of natural fiber.

PHYSICAL CHARACTERISTICS

The most important physical characteristics with respect to the behavior of textiles during finishing and the properties of the finished fabric are specific gravity, strength and elongation, resilience, moisture absorption and swelling, thermoplasticity.

The specific gravity of the various fibers under discussion is given in the second column of Table 1, from which it is apparent that viscose staple is of approximately the same density as cotton and the other vegetable fibers, whereas, acetate staple is less dense and in this respect is similar to wool and silk. The significance of specific gravity is that, other things being

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

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TABLE 1 SPECIFIC GRAVITY AND MOISTURE-ABSORBING PROPERTIES OF VARIOUS STAPLE FIBERS

Fiber	Specific gravity[a], air-dry	Moisture regain—At 65 per cent rel hum, per cent	Moisture regain—At 100 per cent rel hum, per cent	Swelling in water (increase in cross section from air-dry to wet), per cent
Silk (boiled-off)	1.30	11.5	35	41
Wool (scoured)	1.31	14.7	33	32
Cotton (scoured)	1.54	7.0	21–27	44
Viscose	1.54	13.1	45	35–52
Acetate	1.32	6.0	18	9–14
Nylon	1.14	4.1	8	...
Glass	2.60	0	...	0

[a] Selected from various sources; other data from (5, 6, 7, 8).

TABLE 2 STRENGTH OF STAPLE FIBERS IN AIR-DRY STATE AND WET STRENGTH REFERRED THERETO

Fiber	Air-dry strength, g per denier	Wet strength as percentage of dry strength, per cent
Cotton	2.7–5.9	110–120
Wool	1.2–1.7	80– 90
Silk	2.8–3.3	75– 85
Acetate	1.3–1.7[a]	65– 70
Viscose	1.8–2.2[a]	45– 55

[a] Strong viscose staple is already available in this country with a dry strength of between 3 and 3.5 g per denier, and acetate filaments with a strength of 5 g per denier are being made abroad.

equal, the lower the specific gravity of a textile fiber the better the cover and fullness which can be obtained from a given number of threads of a given size or count.

The actual values obtained for fiber strength and elongation are so dependent upon the test methods and atmospheric conditions, as well as upon variations in individual fibers, that comparison of figures obtained by different laboratories on different samples is difficult. Strength and elongation are often determined on the wet fiber, as well as in the dry state under standard conditions of humidity and temperature. The rayon staples have inherited the progress in physical properties which has been accomplished during the years of developing continuous-filament yarns, and the regular varieties are amply strong for the demands of apparel and decorative uses. In addition, strong viscose staple, made by processes similar to those used for rayon tire yarns, is now available for spinning finer yarns or for making stronger spun-rayon fabrics where desired.

In the air-dry state, the rayon staples, except for the specially strong varieties, are not as strong as silk or cotton fibers, but are stronger than wool. In the wet state, they lose a greater percentage of their strength than do the natural fibers and should, therefore, be handled more carefully than the natural staples during all stages of wet processing. Acetate is less sensitive than viscose in this respect, and both rayons recover their full strength upon drying.

In Table 2, the second column gives a range of conditioned or air-dry strength for each fiber from data accumulated from the literature. In the third column, the wet strength is expressed as a percentage of the dry strength, as determined in a set of comparative tests made by Obermiller (4).

In considering strength in relation to dyeing and finishing operations, two things should be remembered: (*a*) The strength of the yarn and of the fabric depends not only upon the tensile strength of the fiber substance, but also upon the design of yarn and fabric with respect to fiber fineness and length, yarn twist and count, and fabric construction and weave; (*b*) the breaking strength is not as important as the resistance to stretching at loads well below the ultimate strength of the fabric. This resistance to stretching is a function of the stress-strain behavior of the fiber as well as of the other constructional factors already enumerated.

The measurement of resilience of fibers and of fabrics has not yet been reduced to a universally acceptable procedure. Therefore, quantitative data on this subject are very scarce. From the work which has been done, however, it is evident that there is a marked difference in the resilience of wool as compared to cotton. Of the two rayon staples, the behavior of viscose is rather similar to that of cotton, whereas acetate staple is much closer to the resilience of wool.

For the dyer and finisher, the most important physical characteristics of a fiber are undoubtedly the group which includes the influence of moisture, of heat, and of tension, because textiles are subjected to a combination of these three factors at almost every stage of wet- and dry-finishing.

All of the textile fibers under discussion are hygroscopic and the amount of moisture which they absorb when exposed to various relative humidities from zero to full saturation is indicated in Fig. 1, which is plotted from data published by Urquhart and Eckersall (5), Speakman and Cooper (6), and Clayton (7). The curves given are for absorption or approach of equilibrium from the dry side. The corresponding curves for desorption, that is, approach to equilibrium from the wet side, lie somewhat higher because each material exhibits a hysteresis effect with reference to moisture. For example, at 65 per cent relative humidity, the moisture regain of wool is 14.8 per cent for absorption and 15.5 per cent for desorption. For acetate staple, the figures are 6 per cent for absorption and 7.8 per cent for desorption.

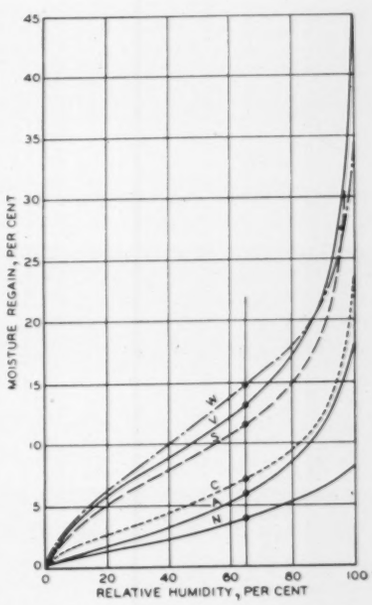

FIG. 1 MOISTURE ABSORPTION OF TEXTILE FIBERS

(*W* = wool, *V* = viscose rayon, *S* = silk, *C* = cotton, *A* = acetate rayon, *N* = nylon.)

Table 1, third column, gives the moisture regain (per cent of moisture based on dry weight of fiber) for each fiber when conditioned from the dry side to equilibrium with an atmosphere containing 65 per cent relative humidity, which represents standard conditions for air-dry testing. The fourth column shows the maximum moisture regain which is absorbed in a fully saturated atmosphere. The last column in this table gives a measure of the swelling which is produced by this absorbed moisture, as measured by the percentage increase in the area of the fiber cross section upon going from an atmosphere of 65 per cent relative humidity to the wet state. From Fig. 1 and Table 1 it may be noted that wool is the most hygroscopic of the fibers under consideration, with viscose rayon and silk rather close to wool in this respect. Cotton and acetate, on the other hand, are less hygroscopic and the amount of moisture absorbed by acetate at any humidity is somewhat less than one half that absorbed by viscose or wool. This greater insensitivity to water is also shown by the fact that acetate

swells much less than the other fibers in the presence of water. This is favorable from the standpoint of loss of strength, but it necessitates careful and thorough wetting out of acetate goods before dyeing or other wet-processing in order properly to swell and soften the fibers.

The absorption of water and the consequent swelling of any fiber effects an internal lubrication and a softening of the fiber structure which results in a lower wet strength (except in the case of cotton) and a higher wet elongation and, consequently, a marked decrease in the resistance to tension. Although all textile fibers show plastic flow superimposed upon their elastic properties and, therefore, strictly speaking, are not characterized by a modulus of elasticity, several investigators have attempted to determine Young's modulus for textile fibers by differentiating between the plastic and the elastic phenomena. There are no figures of this type available on rayon fibers, but the data (9) in Table 3 for silk, cotton, and wool are of interest

TABLE 3 EFFECT OF MOISTURE ON YOUNG'S MODULUS FOR NATURAL FIBERS

Fiber	Young's modulus, dynes per cm² × 10¹⁰ At 65 per cent rel hum	Wet
Silk	8.0	5.1
Raw cotton	6.0	3.2
Wool	3.5	1.3

because they indicate the extent to which moisture reduces Young's modulus, that is, increases the ease with which a fiber can be stretched, even in the case of cotton, the tensile strength of which actually increases as its moisture content increases.

Although the effect of moisture and swelling on strength and resistance to stretching is adverse, this softening of textile fibers improves their receptivity to dyes and chemicals and their flexibility to mechanical working and, therefore, contributes to their successful manipulation in dyeing and finishing.

When the influence of heat is added to that of tension and of moisture, the relative behaviors of the fibers are further altered. Again they fall into two classes, namely, viscose and cotton, on the one hand, which are relatively insensitive to temperature except for the linear thermal expansion, which is the normal behavior of any solid; and wool and acetate, on the other hand, which are decidedly thermoplastic. Here again, no sound comparison of all of the fibers in question under comparative conditions of test has been published, but a study which was made on viscose, acetate, and cuprammonium rayons several years ago by Stahl (10), whose results are summarized in Fig. 2, will illustrate the point. A weight equal to a given

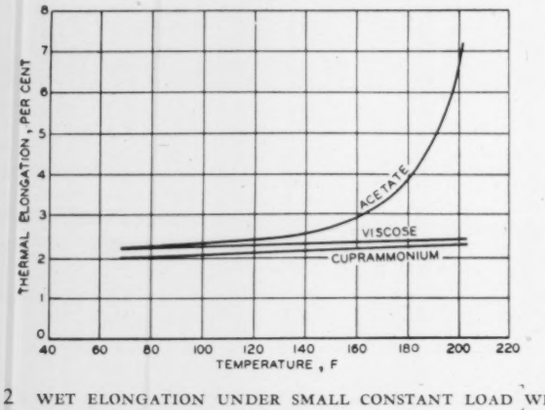

FIG. 2 WET ELONGATION UNDER SMALL CONSTANT LOAD WITH INCREASING TEMPERATURE

fraction of the breaking load was hung on a fiber of each type of rayon and the fibers were suspended in water. As the temperature was raised, the cuprammonium and viscose fibers showed the expected linear expansion throughout the temperature range studied, namely, 60 to 200 F. In the case of the acetate fiber, however, the linear expansion changed in the neighborhood of 150 F into a flow or stretch which increased in rate as the temperature increased. In the dry state, of course, this thermoplastic behavior starts at a considerably higher temperature, but, in the wet state, it occurs in the range of temperatures employed in boil-off and dyeing.

The rather complex behavior of textile fibers under the combined influences of moisture, heat, and mechanical forces is the basis not only for the difficulties which the dyer and finisher has to overcome in handling textiles, but also of his ability to create beautiful finishes by utilizing this behavior to advantage.

CHEMICAL CHARACTERISTICS

The chemical characteristics of rayon staples, which are of importance to the dyer and finisher, include the affinity for dyes and the influence of such chemicals as acids, alkalies, oxidizing agents, and finishing materials.

Viscose-rayon staple is pure cellulose and, therefore, has an affinity for the same dyes which are used on cotton or linen, but it shows a greater absorption for these dyes than do the natural fibers. Acetate staple, like acetate-rayon yarn, is, in general, resistant to the dyes used on other fibers and is dyed with the so-called acetate dyes of which the most commonly used represent insoluble but very finely dispersed dyes that are dissolved or absorbed by the cellulose acetate.

Recently, there has been a great deal of experimentation on methods of dyeing acetate with other dyes. For example, a considerable volume of acetate yarn is dyed with acid dyestuffs, using a bath containing alcohol to swell the fibers so as to permit the absorption of these wool dyestuffs which will not go on under ordinary conditions. Dyeings done in this way are unusually fast to boil off and washing. Furthermore, one or two of the finishers are now successfully dyeing acetate fabrics with vat dyes in pastel shades and are thereby obtaining an unusually good fastness to light.

For the choice of dyes and dye methods, the dyer and finisher who is embarking upon the handling of fabrics made in whole or in part of viscose- or acetate-rayon staple should draw, without hesitation, on the experience of the dye manufacturers from whom he has been purchasing his dyes. Their continuous contacts with the industry and experience with their own and competitors' colors give them an excellent knowledge of individual dyes and of dyeing methods.

With respect to acids and alkalies, a good general rule to remember is that mineral acids are the enemies of viscose staple, and all alkalies, of acetate staple. In other words, viscose staple can be tendered by acid hydrolysis and destroyed completely by high concentrations of acids such as are used in carbonizing wool. Viscose goods, on the other hand, are often given a preliminary treatment in caustic-soda solution to swell the fibers and improve the fullness of the fabric. Acetate staple will withstand acid treatments better than viscose and can, in fact, survive the carbonizing process when carefully carried out. Treatment in hot alkaline liquors, however, causes a saponification, or splitting off of acetic acid, with consequent regeneration of cellulose. The result of this is a loss in weight, strength, and luster, and the acquisition of an affinity for cotton or viscose dyes. This saponification is to be strictly avoided because it tends to destroy all of the properties for which acetate is valued.

Viscose and acetate staples are both very white and, therefore, bleaching is seldom necessary as far as these fibers themselves

are concerned. However, because of the presence of soil acquired during spinning and weaving, or in fabrics containing natural fibers, which have to be bleached to obtain a whiteness comparable to the rayons, bleaching is frequently employed for whites and very light shades.

Viscose rayon is a hydrated or "activated" form of cellulose and, therefore, while it reacts to bleaching agents in a manner similar to cotton, it is more sensitive to overoxidation than the latter. Bleaching with chlorine or hypochlorite is, therefore, carried out with lower concentrations in a cold, alkaline bath. Peroxide bleaching is very satisfactory because of the control of the rate of oxidation, which can be obtained by adjustments of pH and temperature.

For acetate rayon, peroxide bleaching is to be preferred and is often carried out at a pH of between 9 and 10 and a temperature of about 160 F, using approximately 1 per cent of 100-volume hydrogen peroxide. When hypochlorite is used, the bath should be on the acid side (in the neighborhood of pH 5) in order to avoid tendering. The concentration of the available chlorine should be low, in the neighborhood of 1 g per l.

Softening agents which are applicable to either viscose or acetate include sulphonated oils, sulphonated alcohols, and the more recently developed cation-active softeners. These latter have substantive affinity for both types of rayon staple and their judicious use therefore produces a softening effect which is much more permanent than the use of the anion-active sulphonated compounds. Obviously, cation-active and anion-active materials should not be used in the same finishing formula because their mutual reaction would render both ineffective.

Resin finishes are used for a number of effects. The crease resistance of viscose staple, either alone or in combination with wool or cotton, can be improved by the application of resins of the urea-formaldehyde type. These resins can be used in the presence of acetate staple, but are not appreciably absorbed by it. The inherent resilience of acetate rayon makes crease-proofing unnecessary and, in fact, acetate staple is being used at the present time to a very large extent in blends with viscose staple or with cotton in order to give a natural resilience to the mixed-fiber fabric.

The acrylate resins can be used on either viscose or acetate staples, or in mixtures of these with one another or with the natural fibers, to produce varying degrees of softness, crispness, or fullness of hand, according to the particular resin used and the method of application.

To use the rayon staples to their best advantage, the designer should strive to achieve the proper texture, hand, and finish by the suitable choice of staple as to type and denier size and by manipulation during the dry-finishing operations, rather than to lean too heavily on the effects of finishing agents, because utilization of the properties of the rayon staples in this manner can go far toward producing lasting textures and finishes.

The application to the actual finishing and dyeing operations of the properties and behavior of the rayon staples which have been discussed may be summarized as follows.

WET-PROCESSING

Desizing. The warp size on spun-rayon goods is usually made with a base of either gelatin or starches and dextrines. Gelatin size should be completely removable in the course of a proper wetting out and boil off or scour. When starches are present, an enzyme treatment is advisable. A mixed enzyme is often used on all goods to insure the solubilizing of whichever type of size may be present.

Boil Off and Scouring. The operations of boil-off and scouring should be carried out in a neutral soap bath containing from one half to several per cent soap, depending upon the other fibers present. For fabrics containing viscose-staple fiber, the addition of sodium carbonate, as practiced in wool-scouring, is permissible but, in the presence of acetate staple, the pH of the scouring bath should in no case be higher than 10 and a plain soap bath is urgently to be recommended. If any alkali is needed for the removal of dirt or for a better scouring action on wool, this should be limited to a small quantity of ammonia. Either type of rayon staple can be scoured at temperatures up to the boil, if necessary, but it is customary to scour at temperatures below 180 F and, in the case of mixtures with wool, the presence of the latter fiber suggests the advisability of even lower temperatures. Bright acetate staple may suffer a partial delustering if handled too long at the boil.

Bleaching. As already pointed out, bleaching may be done with either chlorine or peroxide. When chlorine is used, the bath should be alkaline in the case of viscose fibers and acid in the case of acetate fibers to avoid tendering. The concentration of the chlorine should be low and the bleaching should be done at room temperature. In the case of peroxide, both fibers may be bleached in an alkaline bath at elevated temperatures and the pH and concentration are usually adjusted so as to control the evolution of oxygen to the slowest rate that the time available for this process will permit.

Dyeing. Both types of rayon staple may be dyed in the form of stock, top, yarn, or piece goods, and yarns may be dyed in packages or in skeins. In stock dyeing, the load per machine should be reduced because of a tendency of the swollen, softened fibers to mat and form channels. When dyeing acetate-staple tops or spun yarn in package form, dyes with the highest degree of dispersion should be selected to avoid the shading caused by the filtering action of the package on large particles.

Viscose staple can be cross-dyed with wool so as to leave either fiber white or to produce a two-color effect by the suitable selection of dyestuffs. For two-color effects, the best control is obtained by dyeing the wool first with acid colors and subsequently dyeing the viscose with direct colors in a neutral bath with salt. Solid shades can be obtained by the careful selection of neutral-dyeing union dyes, but better control here also is often obtained by using a two-bath process. The wool in viscose and wool mixtures may also be dyed with chrome colors by selecting, for the viscose, direct colors which will withstand chroming. Use of mineral acids should be avoided; acetic or formic acids are usually used with the acid-dyeing dyes.

Mixtures of acetate-rayon staple with viscose or cotton may be dyed so as to leave either fiber white or to produce a two-color effect or a solid shade. In each case, the dyeing may be done by a one-bath process starting with a neutral soap solution and adding salt as the dyeing progresses in order to drive the direct dyes onto the viscose fiber.

Mixtures of acetate staple and wool can be dyed so as to leave the acetate white or cross-dyed in two colors by the careful selection of dyes. Because most of the acetate dyes stain wool, it is difficult to dye a mixture so as to leave the wool white, and particular care must be taken when dyeing two-color effects to select acetate dyes which stain the wool as little as possible. In dyeing acetate-wool mixtures, leaving the acetate white, the wool may be dyed either with acid dyestuffs or chrome dyestuffs, properly selected with respect to their indifference to acetate. In dyeing two colors, the acetate is usually dyed first with dispersed acetate dyes and the wool is then dyed in the same bath by adding acid dyes in the presence of Glauber's salt and an organic acid. Purer colors are obtained by conducting the foregoing operations separately rather than as a one-bath process. For solid shades, the goods can be dyed in one bath starting with both dyes in a neutral bath containing Glauber's salt and adding the acid after the acetate fiber has attained most of its shade.

In any dyeing operation in which two fibers are being dyed,

either in solid shades or in two different colors, great care should be taken to select dyes for each fiber which will show the least possible staining on the other fiber, because the color produced by such staining is often fugitive to light and other agencies and will, therefore, result in poor fastness qualities of the finished goods.

Fulling. The fulling of wool fabrics, containing either viscose- or acetate rayon staple fiber, can be carried out safely provided that, in the case of acetate staple, the soaping solution does not contain any alkali. However, neither of the rayon staples has any fulling property of its own and, therefore, nothing is to be gained by fulling except in those fabrics which are predominantly wool.

Carbonizing. Carbonizing will destroy viscose staple as readily as it destroys cotton or other vegetable matter. Therefore, in any blends containing wool which should be carbonized, this must be done in stock form before making up the blend. Acetate staple resists carbonizing, although it is more likely to be damaged than wool. Therefore, if carbonizing of wool goods containing acetate staple is necessary, the concentration of acid and the temperature should be carefully studied. It has been suggested that carbonizing with aluminum chloride is less destructive to acetate staple. The removal of acetate fibers from wool by carbonizing presents difficulties which have not yet been overcome.

Napping or Gigging. The napping or gigging operation is best done in the moist or wet state because the fibers are much more flexible in this condition and, therefore, they can be raised with less destruction and breakage.

Drying. The drying of textiles has a very profound influence on the character of the final finish. A study of drying which is now being conducted by the United States Institute for Textile Research has produced data which have already proved very useful to the cooperators who have supported this research and which undoubtedly will be valuable to the entire industry when it is released for general publication.

It has long been known that when all of the moisture has been removed from a fabric by drying it to a "bone-dry" condition, the subsequent regain of moisture when the fabric is again exposed to normal atmospheric conditions is less than that which it originally showed and the fabric has become harsh.

The published data on this subject are very fragmentary, but Fig. 3 is taken from a study of such data made in 1937 with respect to acetate, cotton, and wool (11). From practical experience, it is believed that, in order to avoid the undesirable effects of overdrying, the moisture regain in wool should not be allowed to drop below 5 per cent, and in cotton or acetate rayon, below 2.5 per cent. The curves show the relative humidity required in the drier air at different temperatures in order to maintain this safe moisture regain in the fibers. They indicate that, for goods containing acetate rayon, the drier humidity should be maintained at approximately twice the value necessary for cotton or wool. It is also apparent that, as the drying temperature increases, the relative humidity must be increased in order to prevent overdrying. The publication of the results of the drying research work referred to will undoubtedly provide much more comprehensive data on this important phase of finishing.

Air-drying is always superior to can-drying, especially on acetate rayon staple, because the contact of the fibers with hot metal surfaces tends to produce a thin, hard hand and, in the case of excessive temperatures, a glazed appearance.

DRY-PROCESSING

Fabrics containing viscose- or acetate-rayon-staple fibers can be handled with no special precautions in the final or dry-finishing operations, such as steaming, brushing, pressing, decating, shearing, tentering, and calendering. It is here that the woolen and worsted finishing plant should be able to manipulate spun-rayon fabrics so as to produce effects which are not readily obtainable with the usual rayon-finishing

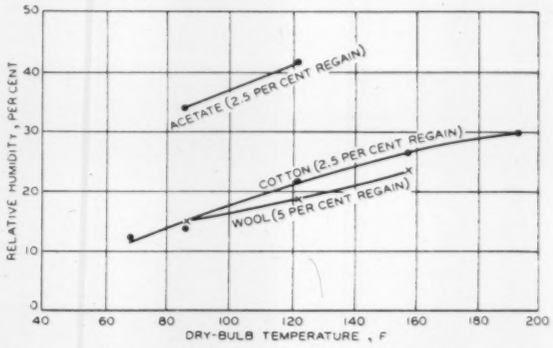

FIG. 3 RELATIVE HUMIDITY REQUIRED TO MAINTAIN SAFE MOISTURE REGAIN WITH INCREASING TEMPERATURE

equipment. Viscose staple will react somewhat like cotton in these operations. In handling acetate staple, its resemblance to wool with respect to thermoplasticity and resilience should be kept in mind.

The utilization of rayon-staple fibers, either alone or in blends, is comparatively new and the fabric designer is only beginning to explore the versatility in fabric weight, pattern, texture, and finish which he may be able to attain by the intelligent use of these new fibers. The dyer and finisher can contribute a great deal to this development by a study of the properties and behavior of the rayon-staple fibers, such as has been indicated in this paper. If he will learn to know the individual character of the two rayon staples as he already knows those of cotton and wool, his long experience with the processing of the natural fibers will enable him to utilize the distinctive properties of the newcomers in the field to his own advantage and, therefore, to that of the entire industry.

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National Collective Bargaining in GREAT BRITAIN *and* SWEDEN[1]

What Is Ahead of the United States Judging From Their Experience?

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THE expansion of labor-union organization and collective bargaining in the United States since the passage of the Wagner Act is such as to suggest that it will continue. The present-day unions are generally sturdy. The power of organized labor is now such that, regardless of what political party is in Washington, it is probable that safeguards of labor organization adequate to protect its gains and give it a firm basis for growth, will remain on our statute books.

As labor organization has expanded, our principal unions have become more truly national in character. As they have done so, some have begun to negotiate collective agreements on a national or industry-wide basis. In some industries the employers have grouped together and have dealt with labor as a unit.

This trend toward collective bargaining on a national scale is likely to be accelerated if American industry becomes faced by the need of the mobilization of its resources for national defense. For such mobilization, as it did in the former war, will probably bring in its train the necessity for orderly regulation of wages, hours, and other basic aspects of industrial relations in each industry on a national basis. Since in England and in Sweden industrial relations have for years been conducted on this basis, the experience of these countries in this regard holds much of interest to us.

The differences between the industrial conditions which exist in England and Sweden and those which exist in America are great. Above all else in importance is the fact that their working populations are homogenous while ours is a mixture of nationalities. The differences, however, between England and Sweden are also striking. England is large, Sweden small. England is almost wholly industrial, Sweden largely agricultural. The population of England is concentrated, that of Sweden widely diffused. Yet the fact that there is much that is common in the development of collective bargaining in these two countries suggests that in some measure the experience of these countries may be applicable here.

THE DEVELOPMENT OF NATIONAL COLLECTIVE BARGAINING[2]

In both England and Sweden the growth of labor unions has been followed by the development of organizations of manufacturers created for the exclusive purpose of dealing with them. The unions, after they gained power in any locality, in order to protect themselves from flank attack by "chiselers" in other localities, gradually expanded and federated until they were national in scope. The employers' associations, if they were to negotiate effectively with national unions, had to expand or federate in order to deal with them as a whole, instead of being played off one against another. Thus in both countries the growth of national unions has been followed by the growth of national employers' associations. This suggests that as labor organization in this country proceeds, there is considerable likelihood that the participation of employers in collective negotiation will become nationally organized.

In both England and Sweden the employers' associations first grew up to defeat and, if possible, to destroy the unions, not to bargain collectively with them. Their growth was followed by a period of collective combat during which the forces on both sides grew stronger and stronger, and the areas of combat greater and greater. Collective combat shifted over to established collective bargaining only when the employers and unions agreed that thereafter wages, hours, and basic working conditions would be permanently controlled by collective agreements between them.

Collective bargaining in England and Sweden differs fundamentally from collective bargaining as it most commonly exists here. For there the union deals not with the individual employer but with the employers' association or a federation of associations; and the bargain governs the entire industry. Even local variations in wages due to cost of living and such factors are often covered in the national agreements, although local associations and local unions may make local agreements supplementing the national ones. The agreements are as definite as to what is required of labor as they are as to what is required of the employer, for they are not negotiated as demands by labor against an employer; but as a common meeting of minds as to the part to be played by each side in establishing the basis for industrial relations.

In Sweden, where labor is almost completely organized, an employer who employs union labor obviously has to pay the national wage scales arrived at by collective bargaining whether he is a member of a bargaining association or not. In England, although less than a majority of the workers are organized, national collective agreements nonetheless cover most industries and are the principal basis of hour and wage scales for the whole country.

MAKING COLLECTIVE CONTRACTS RELIABLE

Once the regulation of the industrial relations by national collective bargaining was firmly established, the common interests of organized labor and organized capital became more clear. Both parties, like those in commercial bargaining, learned to recognize the value of being able to deal with a competent and reliable party on the other side. For with contracts covering labor, even more than with commercial contracts, legal compulsion or damages is an inadequate substitute for voluntary compliance. With labor contracts, moreover, unless they apply to all concerned, those who are covered by them are exposed to unfair competition from those who are not, and the whole

[1] This article is based on a study of British and Swedish industrial relations made in those countries in the spring and summer of 1939. Important employers, officers of unions and employer associations, and government officials were interviewed, and much time spent in factories and mills.

[2] The statements in this article all relate to the experience of Great Britain and Sweden prior to the outbreak of the present war.

basis of industrial relations which they aim to set up is undermined.

Almost invariably the heads of both unions and employers' associations in Sweden and in England spoke of their desire to have a strong, well-disciplined body to deal with on the other side, and one with large enough membership to cause the collective contract effectively to cover the entire industry. They spoke also of the consequent support which labor and employer organizations alike frequently render to each other. As a result, the national unions and employers' associations have acquired great stability without which the machinery of collective bargaining could not function as it does.

In both countries the heads of employers' associations respect the union leaders, and this respect is returned. Never in either country did I hear employers or employer-association officials belittle the union leaders with whom they dealt, or vice versa. To an American the general attitude of friendliness and trust between the leaders on both sides was striking.

As collective bargaining has proceeded it has also become increasingly clear that, fully as much as commercial contracts, collective contracts require provisions for their authoritative interpretation. Thus today almost all collective contracts provide procedures for the voluntary adjustments of disputes as to their interpretation and fulfillment, and in all industries in both countries the procedures that have thus grown out of the dictates of experience are fundamentally alike.

They provide that if differences arise as to the interpretation or fulfillment of the contract, before a strike may be called an effort at voluntary adjustment must be made, first by a series of negotiations within the plant and if this fails then by negotiations between representatives of the employers' association and of the union. These representatives must not be party to the dispute, so that they may view it with detachment and with the point of view of the industry as a whole. Only if these negotiations fail to bring about a common understanding is a strike permissible.

In England an appeal to arbitration is also provided for in some industries, but such arbitration is advisory only and not binding on the parties. In some there is no appeal. In either case, the enforcement of collective agreements rests everywhere solely upon moral force, but the determination of both sides to make collective agreements reliable has made this moral force adequate.

Sweden has supplemented voluntary adjustment of disputes as to collective contracts by provision for their legal interpretation. Collective contracts are declared by statute to be like commercial contracts, enforceable at law, and a special labor court is provided to enforce them. Under this law, once a collective contract is made for an industry it is binding on the parties. To call a strike or a lockout to secure compliance with it, instead of going to the labor court, is illegal. But collective contracts may provide, and usually do, that the standard voluntary adjustment procedure must be gone through before a question of the interpretation of the contract is taken into the labor court.

The Labor Court, though presided over by jurists, has members representing capital and labor. This was provided so that the body charged with the interpretation of collective labor contracts would be equipped to take account of the customs, conditions, and requirements of industrial relations, instead of tending to apply to them without change the traditions of the regulation of commercial dealings. The court has no power over the making of commercial contracts; but in interpreting them it has the same power as a civil court. Although decisions of the court are binding precedents, if the contracting parties of an industry do not wish to be bound by any precedent, they can reword their contract to negate it. In the nine years of its existence, all decisions of the court have been unanimous. Universally among capital and labor I found respect for its decisions and recognition of its value.[3]

SAFEGUARDS OF INDUSTRIAL PEACE

The procedure for interpreting collective agreements is equally a safeguard of industrial peace. Moreover its process of negotiation is almost invariably applied to the peaceful settlement of grievances. All collective contracts also contain procedures for peaceful renewal and amendment. The contract is made for a set period during which no strike to alter it may occur. The contract is automatically renewed unless denounced several months in advance of the terminating date. In the meantime a series of negotiations must be gone through to bring about peaceful amendment and renewal if possible. Sometimes nonbinding arbitration or a process of conciliation is provided for.

With the regulation of industrial relations by collective bargaining firmly established, trade unions and employers' associations have tended to abandon destructive tactics. This was especially clearly evidenced in Sweden when collective bargaining was established for the whole nation at one time. Manufacturers and labor leaders unanimously stated that the type of labor leader changed from the fighter to the fair-minded negotiator. The demands of the unions for such protective devices as the closed shop or checkoff were dropped and have never been reasserted. Discrimination by employers against union employees and other efforts to undermine the unions grew less. Strikes became fewer and more moderate.

In England the change was gradual. Here and there excessive strikes and lockouts that were costly and led to little advantage gradually taught moderation when compared with the results of peaceful negotiation. The officials in charge of collective bargaining became accustomed to working together and grew to understand each other's problems. They acquired skill in the art of negotiating and wisdom in knowing what to demand.

While strikes have continued they have grown less frequent, less bitter, shorter, and more orderly. As the United States Commission on Industrial Relations in England pointed out, "The conduct of both sides in strikes and lockouts is tempered by the fact that the established collective relations, which both parties expect to resume at the end of the dispute, have real weight and value"[4]

Under present conditions British manufacturers are so little concerned by fears of labor disorder that none of the executives with whom I discussed industrial relations mentioned as significant the laws restricting mass picketing passed after the general strike in 1927. Labor spies, as far as I could determine, were unknown, and generally pronounced "unthinkable." Efforts to weaken the union were everywhere considered incompatible with the successful operation of recognized collective bargaining.

With very few exceptions, in both England and Sweden, employers and employer-association executives, as well as union heads, stated that the development of national collective bargaining had provided a constructive basis for the ordering of industrial relations and one which promoted industrial peace.

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[3] A more detailed discussion of the Swedish Labor Court is given in the Appendix, pp. 597–598.

[4] "Report of the Commission on Industrial Relations in Great Britain," p. 24. See also similar statement in the "Report of the Commission on Industrial Relations in Sweden," p. 9. These reports are exceptionally clear authoritative documents outlining the general structure of industrial relations, giving in full the principal statutes relating to industrial relations and the text of typical collective agreements. They may be procured from the Superintendent of Documents, Washington, D. C.

Almost without exception the common interests of both sides in peaceful bargaining, in peaceful interpretation of the bargain, and in strong bodies to bargain with, were recognized. A joint statement issued by employers' associations and unions in Sweden in 1939 states: "The central organizations of the Swedish labor market . . . deem it to be their chief mission to seek to employ all possible means for settling disputes in a peaceful way. Both parties have come to realize that the results gained through open conflict rarely stand in proportion to the costs and other sacrifices connected with the conflict."

KEEPING GOVERNMENT OUT OF INDUSTRIAL RELATIONS

In the great general strikes both in Sweden and in England, the public made clear that it had an interest in industrial peace and was prepared to protect it. Since those times public attitude and government action have repeatedly reminded employers' associations and unions that unless they are capable of settling their disputes without interfering with the public good, government is likely to step in. This, both labor and capital have watched with a jealous eye. In contrast to America, organized labor, as well as the employers, has actively resisted the intrusion of government into industrial relations.

A Swedish government official pointed out, "Labor feels that it now has something to defend against the government. If the state intervenes in collective bargaining, labor now loses power while before it had nothing to lose. Practically all workers are organized. They think they can get more by bargaining power than they can through government action." The president of a large industry confirmed this as follows: "Labor knows the bargaining process and how to conduct it. It has confidence in it as a means of labor welfare and it has experience with no other process. Hence it wants it, and the system of private business on which it is based, to continue. It may talk socialization but in action it is against it."

When the government of Sweden undertook measures to regulate industrial disputes, both sides resisted. Labor and employers have also opposed all wage regulation, even minimum wages. Labor looked with distrust upon the Labor Court until it demonstrated that it was not a measure of government intervention in collective bargaining but merely a means of interpretation of collective bargains freely made. Both sides have watched carefully to insure that measures of mediation did not pass over into compulsory arbitration. No requirement as to incorporation or registration of unions has been enacted.

In England, as has been stated, both capital and labor have repudiated all plans to make collective contracts subject to legal interpretation or binding arbitration of any sort. Incorporation of unions has been prohibited by statute; and registration and certification made voluntary means of securing exemption of union benefit funds from taxation on compliance with certain procedures as to the filing of accounts, not means of government regulation of unions.

Even the right to strike and lock out, as a part of the bargaining process, has been carefully safeguarded from government control in both countries. In Sweden there is no statutory restriction of strike activities. In England, although picketing "in such number" as to "intimidate" has been prohibited, trade unions have been made immune from suit for conspiracy or wrongful actions done in furtherance of a trade dispute, and except in regard to strikes called in order to put pressure upon the government, these safeguards of the right to strike survived the wave of public indignation following the general strike in 1927.

In both Great Britain and Sweden the association and union not only negotiate the collective agreements but also largely control their interpretation and enforcement. As a result, the distinction between collective bargaining and plant management has become sharply drawn. If a matter is covered directly or by implication in a collective contract it ceases to be in the control of local management. This has made it important that national collective contracts confine themselves to basic problems of industrial relations and keep out of local matters. The individual employer has realized that anything which gets into the contract is taken out of his hands, and has been critical of his association if managerial matters slip into the contract.

With security of organization assured, the national unions have shown small tendency to seek to make managerial matters questions of bargaining. In most contracts in both countries, for instance, individual piece rates are commonly treated as plant matters to be handled by management directly with the individual employees concerned, subject only to a basic wage.[5] Similarly, questions of discipline, selection of workers, and the like, are typically left to the discretion of the individual employer. The greatest difficulty arises in trying to keep the right of dismissal free from confusion with the problem of discrimination, and clearly in management's hands. Although the words of the contract are usually otherwise, it was my observation that, in Sweden especially, the unions had gained a considerable voice in the question of discharge.

NATIONAL CONTRACTS AND INTERNAL MANAGEMENT

With competitive matters, such as wages and hours, determined by the industry, the relation of the individual employer and his own employees has been put upon a nonbargaining basis. This makes it easier for worker and manager to pull together on a friendly cooperative basis in their common task of "getting out the goods." Even if a local union exists, the nonbargaining relationship is not altered. The local union ordinarily has no power to make collective agreements with the employer but only with the local employers' association. Hence, neither association nor union is concerned with what goes on within the shop until some dispute between the employer and his worker, which cannot be settled locally, comes up for settlement. Even then, the union usually deals with the association, not the employer. As a result, in most industries "the employer in his internal affairs," as even one of the few antiunion employers I met in England phrased it, "can operate on a *de facto* nonunion basis."

In most companies in Sweden, even small ones, local union "clubs" have grown up among the employees to collect dues and to discuss union affairs. The heads of these clubs deal informally with the management on employee-management problems. In the large companies, particularly those remote from Stockholm, the club has tended to become a *de facto* company union. All of its members are employees of the concern and almost all employees of the concern are members. The management deals with its committee on all plant matters.

In England, in many large companies, works committees have also been developed. Sometimes the representatives are selected by the unions from among their membership within the concern. Sometimes they are elected from the employee body as a whole just as works committee representatives in this country are elected. Sometimes no such committees exist at all. In some plants there are shop stewards—employees of the company designated by the union to represent its members in a department or plant. Some companies allow no shop stewards in their plants at all. Almost everywhere, however, except in a few old traditional industries, the result of national collective bargaining, in England as in Sweden, has been that

[5] In the old traditional industries collective contracts are usually more specific, covering exact rates per piece and other questions which are not basic conditions but matters relating to the management of the individual concern.

the individual employer in dealing with representatives of his employees always deals with his own people and deals with them on a nonbargaining basis. He refers matters to them which he desires to have them understand, or to which he desires to secure employee opinion. They bring matters to his attention, or to the attention of his subordinates, which they think need remedying. No negotiation occurs and no contract results.

Wherever there are union representatives, however, there is a danger that they may intervene between the individual employee and his boss. In several British industries this danger has led to serious struggles. Thus in 1922 the unions in the engineering industry refused to allow their men to work overtime unless the requests were made through the shop stewards. This refusal was not overcome until the matter had been fought out by a long lockout that covered the entire industry. Since then the right of management to handle directly all assignments of men to work, whether for overtime or otherwise, has never been questioned. Manufacturers often asserted that with most unions a test case had to be fought out and won before the union representatives fully recognized that they had no part in questions of management.

In general it was my observation that the degree to which local management in operating within the collective agreement was free from external interference was largely in its own hands. If it was incompetent in settling grievances at the source, matters of internal management were certain to be appealed to the association and the union. If incompetent management, as it sometimes did, appealed to the union officers to get its employees to live up to their contracts, it thereby abdicated its disciplinary powers. If it supinely submitted questions of industrial relations that it should have decided or handled for itself to its employers' association, to that extent it abdicated its functions to it. But if management was competent in handling its own employee relations, it had little difficulty in keeping their management in its own hands.

The fact that the employer or local manager had no bargaining relations with the union, and that the bargaining was done between employers' associations and central unions, strengthened his hand in keeping matters of local management free from union intermeddling. The stability of industrial relations, the protection of the individual employer from competitive wage cutting, and his removal from the process of bargaining which have resulted from national collective bargaining by employers' associations was valued by every employer and union representative with whom I spoke. While a few employers expressed antipathy to unions, none that I met questioned the desirability of national collective bargaining if organized labor had to be dealt with at all.

MONOPOLISTIC BARGAINING

The national unions and employers' associations which conduct collective bargaining are centralized. In spite of democratic form, the actual control of policy is largely in the hands of their officers and executive committees. The officers of the national employers' associations and unions in both countries are usually permanent, paid officials. The executive-committee members are able men who become skilled in handling association affairs, and, through this skill, well-intrenched. They are generally re-elected term after term. Thus, on both sides the bargaining process has become professional. This has brought to it skill and an interest in its successful operation, but it has also concentrated its control in a very few hands.

The centralization of control of collective bargaining is carried further by the existence of general federations of the unions and of employers' associations. In England these federations are loosely organized. In Sweden their control over the associations for the different industries is direct and firm. They are in effect powerful holding companies, exerting their control through their hold on personnel and their presence in all national negotiations. Such centralization of control of industrial relations makes possible an easy shift from private regulation to government control. It may become essential in this country, however, if industrial relations are to be sufficiently firmly regulated to meet the needs of intensive national mobilization.

When, as in a few industries in England and more in Sweden, the membership of the union comprehends almost all the workers in the industry, and the employers' association is likewise comprehensive in membership, they share between them almost complete control of the labor market. In so far as this is true, internal competition as a basis of determining wage levels in the industry has been destroyed. Hitherto, however, in both countries their large export trade has provided competitive price levels that are unaffected by joint agreements as to labor costs, and these price levels have served to set limits to wage levels. But with the development of totalitarian states and national control of international trade, this basis of securing a competitive wage level is tending to disappear. Competition between industries may still provide some basis for setting general wage levels but such competition will not fully replace the determination of wage levels by competition within an industry. As yet, however, as far as I could determine in England and Sweden alike, apart from the building trades, there has been little evidence of unions unfairly exploiting their labor monopoly, or of employer and labor organizations uniting to raise wages at the public expense.

The possibility that two great federations, who share monopolistic power between them, may get together and assert that power, extends beyond the determination of wages to such matters as the sheltering of the unprogressive employers, as well as labor, from the need of adjusting to progressive competition. In general, however, not only has there been little tendency for unions and employers' associations to unite in resisting progress, but the unions have gone so far in seeing the relation of productive efficiency to high wages that union resistance to technological change is rare and cooperation in it is common. In talking with manufacturers as well as labor leaders, I found complete agreement that, in so far as restrictions on progress have developed, they were as much due to the influence of reactionary employers as to that of the labor unions. In vigorous industries, where a majority of the manufacturers were progressive, there was little fear on this score.

Still the evidence is strong that national collective bargaining, although created for the ordering of competition, tends to create a biparty monopoly. A country such as the United States, which is tending in the direction of national collective bargaining, should therefore give serious thought to the problems to which this gives rise.

NATIONAL COLLECTIVE BARGAINING AND POLITICS

Strong national unions and strong national employers' associations inevitably acquire great political power. The more national and complete the organization and the more its control is centralized, the greater its influence over political action. In England and in Sweden not only is labor organization more complete than in America but there are labor parties in both countries, although in Sweden not called by that name. Moreover, the right of organized labor to enter into political activity is more clearly established.

In Sweden, local labor unions may join a political party as a body and the individual union member has to contract out if he does not desire to have part of his union dues diverted to political contribution. In England, unions may also join a

party *en masse*, but since 1927 may not divert the dues of any member without his specific consent. In Sweden many employers assert that the federation of unions is more powerful politically than the Social Democratic party organization itself.

With such political power, there is always a temptation to call upon government aid when bargaining power fails. So far, in both countries this has rarely occurred. The parties having political power have had too definite an interest in keeping the process of collective bargaining in their own hands and free from interference by the general public. But when industries are economically "sick" or their industrial relations are disorganized, the labor standards of the country are undermined. When this has occurred, the influence of organized labor, and in some instances of organized employers, has occasionally been exerted to have the government take a hand. And government aid or control once established has created a reliance upon it which makes it difficult for it later to be withdrawn.

CONCLUSION

The trend of American industrial relations is toward an extension of organized collective bargaining. This trend will be intensified by industrial mobilization for national defense. During a period of national emergency the public interest in industrial peace will inevitably be increased. All industrial relations will become charged with a public interest. It is thus possible that peaceful regulation of industrial relations by national collective bargaining may in this country soon become an alternative to government regulation.

In facing this trend and this alternative it is important to remember that government intervention, once established, is extremely difficult to terminate. It is important to remember also what the common elements in the experience of England and Sweden in regard to national collective bargaining are. As collective bargaining developed in these countries, the growth of labor unions was paralleled by the growth of associations of employers. As this growth went on, the unions and associations in each industry tended to become national in scope, and collective combat between employers and workers thereby expanded to national proportions. This has expanded the scope of strikes and the public desire for government action to regulate them. The possibility of national unions and of national employers' associations uniting to assert monopolistic influence over the labor market arose. The power of organized labor in politics became great.

When national collective bargaining replaced national collective combat, combat tactics on both sides lost importance. Industrial relations were put increasingly upon a cooperative basis. The common interests of both sides in stable industrial relations, in strong contracting parties, in the authoritative interpretation of collective contracts, in industrial peace, and even in industrial efficiency were clarified.

With bargaining recognized and upon a national basis, matters of collective concern were sharply set apart from those of plant management. Individual plant management lost control of the process of bargaining and was exposed to the danger of having matters of internal management become subject to central regulation. So far this danger has not proved serious in progressive industries. Plant management in so far as it has been competent has been aided in keeping itself free from local collective interference in its internal affairs. With collective bargaining on a well-established basis, unions and employers' associations alike have developed an interest in maintaining the bargaining process in their own hands, free from government intrusion. But when the industrial relations of individual industries have become disorganized, the labor forces in government have sometimes enacted measures of regulation.

In general, management in England and Sweden has found national collective bargaining a sound basis for regulating industrial relations. In general, whether its advantages have been secured and its dangers met has largely depended upon the progressiveness of the industry and the competency of employers.

What American management does in industrial relations now will go far toward determining what will happen should collective dealings be expanded to a national scale. For we are building now the traditions and attitudes on which national collective dealings will rest. The union leaders with whom we will have to deal as collective bargaining extends, or during mobilization, will largely be the men who are getting their understanding and habits of industrial relations as officials and members of the unions we are dealing with today. Much of our future supervisory management is also likely to consist of men who are "union-made." Employers' associations, with the great power which they will yield if they expand to national proportions, are for the most part still to be developed. As they develop they will tend to follow the practices and share the attitudes which are now being developed in industrial relations. What sort they will be in so far as they arise will be determined by American management.

Hence it is important to begin now placing such collective dealings as we have on a basis of collective bargaining, not collective strife. It is important to realize that stable contracts can only be made with stable unions, and that unions fighting for their own lives will inevitably use aggressive combat tactics. It is important in all contracts we make now to make them a statement of *mutual* rights and obligations, and to distinguish clearly between matters of bargaining and matters of internal management. In operating under collective contracts it is important for all employers to realize that the matters which can remain in their own hands in the long-run will be determined primarily by their competency in management and their responsiveness to the needs and point of view of their own employees.

Whatever our attitude toward national collective bargaining may be, it is important to realize that under the pressure of a war emergency it may be close upon us, and that it is vital to do our part now to build up a responsible and constructive relationship between the organizations which will then grow into great power. While this provides no direct answer to the baffling problems of determining wage levels in a potentially monopolistic labor market, or keeping the political power of organized labor and organized capital employed for the public good, this will make the chance of finding a solution to these problems much greater.

APPENDIX

THE LABOR COURT IN SWEDEN

The action of the unions and employers' associations to insure the peaceful interpretation and enforcement of their collective agreements, was supplemented in 1928, when the Liberal (employer dominated) Party was in power, by what was at first considered by labor unions as almost repressive legislation. Strikes and lockouts connected with the interpretation, validity, or execution of a collective agreement were made illegal. If a general contract for an industry was made by an association and a union, no employer, union local, or employee might contract out from it. Subagreements had to conform to the general agreement. Although the negotiation process provided in the contract was not interfered with, a collective contract was made, like a commercial contract, enforceable at law and a labor court established to provide for interpretation and enforcement.

The Labor Court consists of a chairman and vice-chairman,

both of whom must be lawyers, and a third general member who is an expert in industrial relations. In addition there are two representatives each of employers and of employees appointed by the Crown from lists submitted by their respective general associations. The function of the court is strictly confined to the interpretation and enforcement of collective agreements. It has no other power. Whatever is lawfully in the agreement it must abide by, and only a few contractual provisions, considered to be against public policy, such as "yellow-dog" contracts or provisions for nonreference to conciliators or the court, are illegal. Regardless of what its previous decisions may have been, or what it thinks is wise, the court must follow the terms of the contract before it. But in doing so it is a court both of first and of final jurisdiction, for there is no appeal from its decisions.

In interpreting collective agreements, the court applies the general law of contract. In doing this, it takes account of the conditions under which collective agreements are made, and also of the traditions and circumstances in the industry which surrounded the making of the contract. As the court has interpreted contract after contract, it has built up a body of precedent which, while making the process of wording collective contracts increasingly legalistic, is giving them greater positiveness and conformity to the actual intent of the parties.

These precedents in large measure particularize the understandings which practice has made implicit in industrial relations. They have thus made explicit the general implicit understanding that piece rates are not to be cut except when the process to which they relate has been changed or a new product made. Thus, also, they have made clear that the right to hire and fire does not carry the right to discharge for union activity, and does imply having some grounds other than mere whim. This, more than any other problem, has led the court out of the position of interpreting the language of a contract into that of determining the facts of whether the agreement has been carried out.

Often the language of collective agreements is loose and vague. They are made in haste, not as legal documents but as means of adjusting emotionally tense impasses. This places upon the court the necessity of interpreting agreements with greater reliance upon external evidence than is customary with commercial contracts. On the one hand, the traditions and circumstances of the industry must be more largely drawn upon. On the other hand, the circumstances of the negotiation itself must be more seriously considered to discover the intent of the parties and what the true meeting of minds was. In particular the court takes care to defeat any taint of "sharp practice" in the making of collective agreements. If it sees any evidence that one party was aware of a misunderstanding of the other, it holds the party that was aware of the misunderstanding bound by the actual understanding of the other regardless of the language of the agreement.

In many cases the language is so vague as to make a clear-cut interpretation impossible even when all surrounding circumstances are considered. If a contract does not purport to cover the matter at all, the question does not come within the jurisdiction of the court but is subject for further negotiation. If, however, the contract purports to settle the question, even if it is extremely vague or elliptical, and even if new circumstances have arisen altering the situation to which the agreement applies, the court undertakes to provide an interpretation. For the primary purpose of the law is to provide assured industrial peace during the term of a collective agreement, and the court can only do this if it makes every possible effort to make the industrial relations problems within the scope of the agreement subject to judicial determination.

Sometimes the contracting parties take advantage of this aspect of the law, and when they cannot reach a clear-cut agreement acceptable to their constituents, deliberately leave it vague for later construction by the court. They hope this will be at a time when the heat of the dispute has abated and when the application to a concrete instance gives the problem greater objectivity and frees it from adhesions to slogans and face-saving. The parties thus in fact contract that within the general scope of the agreement, the issue which they cannot then settle shall be settled later by the court.

This necessity of construing vague language and obscure intent places upon the court at times the necessity of establishing industrial practice beyond the area of either mutual agreement or past precedent. Thus, in interpreting a collective agreement, the question arose as to the basis on which new rates covering new methods should be set. Should they merely exceed hour-minimums? Should they equal past actual earnings—or what? The contracts purported to cover piece-rate setting but were silent on this. There was no clear precedent in the industry.

Piece rates, however, had become a basis of rewarding extra skill as well as extra effort. Piece-rate yields had become stabilized for different types of work at particular levels quite out of line with time-rate minimums. A piece-rate average for a type of work had become as much a wage scale as any hourly pay levels. Hence the court held that the new rate must yield as much as the old.

In making such decisions the court is no longer merely defining the meaning of language, or crystallizing traditional practice. It is setting *de novo* the standard practice of industrial relations in the country. For once such a decision has been handed down, it is law in all contracts unless expressly negatived. In general, industry tends to follow it, and in each new contract it is difficult to get the party favored by the decision to agree to specifically contracting out from it.

In making such decisions, the court considers the question from both sides, as well as from an impartial viewpoint. For two of its members are representatives of the employers, and two are representatives of labor. Each sees that the case is looked at from the point of view of their constituents as well as from that of general industrial needs. Yet in the nine years of its existence nearly all decisions have been unanimous, thus indicating that although there was enough uncertainty to give rise to an issue between the parties directly concerned, the general precedents and requirements of industrial relations have been so clear that there have been no disagreements between representatives of employers and of labor who were removed from the bias of direct involvement in the situation.

The Labor Court, although originally bitterly opposed by organized labor, was soon accepted by both labor and employers as a benefit. Nowhere did I hear a complaint as to its partiality, or question as to its value. No one considered it a questionable intrusion of government into business or industrial relations. For in fact it is not an assumption by government of regulatory powers.

The court is strictly judicial, part of the judicial system of the kingdom, and exercising the same function of judicial interpretation of contracts that the courts have long exercised in other fields and without which commercial industry would be paralyzed. It merely brings to this interpretation a specialized skill, and adds to the growing knowledge of industrial relations of its impartial members, the partial but counterpoised knowledge of people actively engaged on both sides as executives in handling the very subject matter to which these contracts relate. From the viewpoint of labor and employers, the Labor Court has become an instrument for assisting them in the conduct of industrial relations by collective negotiation; and not in any sense an intrusion of government into the process of negotiating.

MECHANIZATION *in the* U. S. ARMY

By H. H. D. HEIBERG

CAPTAIN, CAVALRY, UNITED STATES ARMY

DURING 1929 experiments were conducted by the United States Army with a so-called mechanized force temporarily assembled at Camp Meade, Md., to determine the capabilities and composition of a highly mobile, self-contained force. Results showed that the tank by itself is deaf and comparatively blind, lacks the capacity for prolonged defense, and cannot be used without proper support. However, it was found that it is a powerful offensive weapon and forms the backbone of any mechanized force. Give it airplanes and fast mechanized reconnaissance vehicles for eyes and ears, give it mobile artillery support and troops in mobile carriers who can consolidate and hold the ground that the tank has gained through assault, and there results a balanced mechanized force.

That was the American conception of mechanization in 1930, while Germany was still observing the Versailles Treaty which limited her to an army of 100,000 men and no tanks! That is now the German conception of mechanization as exemplified by the organization of her "panzer" divisions and their successful employment in the Polish "blitzkrieg" (lightning war) last fall. It may be interesting to note here that the shoulder patch now worn by the troops in the mechanized brigade of the U. S. Army was designed in 1931 and represents a gun supported by a tank track with a bolt of lightning superimposed on the whole.

In 1931, a force was directed to assemble at Fort Eustis, Va., to become the nucleus of a permanent mechanized force. About a quarter of a million dollars was appropriated by Congress to purchase seven Christie tanks to be experimented with by this unit. After many experiments by this combined force it was decided that the development of mobile mechanization was a cavalry function and so the following directive was issued: "Mechanized cavalry will be organized to fulfill the normal cavalry role, substituting the vehicle for the horse." The separate mechanized force was then disbanded and some of the men and equipment transferred to the mechanized cavalry which moved overland in November, 1931, to Fort Knox, Ky., where it has been ever since.

The National Defense Act specifically states that tanks shall be a part of the infantry, so, in order to make their use by cavalry legal without amending the act, the word "combat car" was coined and will be used hereafter in this article to differentiate the cavalry tank from the infantry tank.

The War Department, to differentiate between the two main types of automotive equipment, has classified them as follows: Motorized units are those which use the motor vehicle purely as a means of transportation to the field of battle but must dismount their personnel and weapons to fight. These units are usually equipped with commercial production vehicles. Mechanized units are those which are transported on the field of battle in armed and armored vehicles and are capable of fighting from these vehicles. These vehicles have no commercial counterpart and are all specially built. An interesting combination of motorized and mechanized units is the recently reorganized cavalry reconnaissance regiment of which the Sixth Cavalry at Fort Oglethorpe, Ga., is an example.

This regiment is divided into two squadrons. In the motorized squadron men and horses are transported in tractor-trailer units, a complete squad of eight men and horses with all their equipment being carried in each unit. In the mechanized squadron the men are placed in armor-protected scout cars which carry three machine guns ready for instant action in any direction with the vehicle stationary or in motion.

World War I and postwar developments in tanks as well as present-day manufacturing methods were covered in another paper presented before this Society.[1] Some of these developments are illustrated in Fig. 1. Not a mechanical engineer, the author will attempt to cover his subject from a tactical rather than a technical standpoint, based on his experiences with the

1 "The Manufacture of High-Speed Tanks," by John K. Christmas, MECHANICAL ENGINEERING, January, 1939, pp. 13–19.

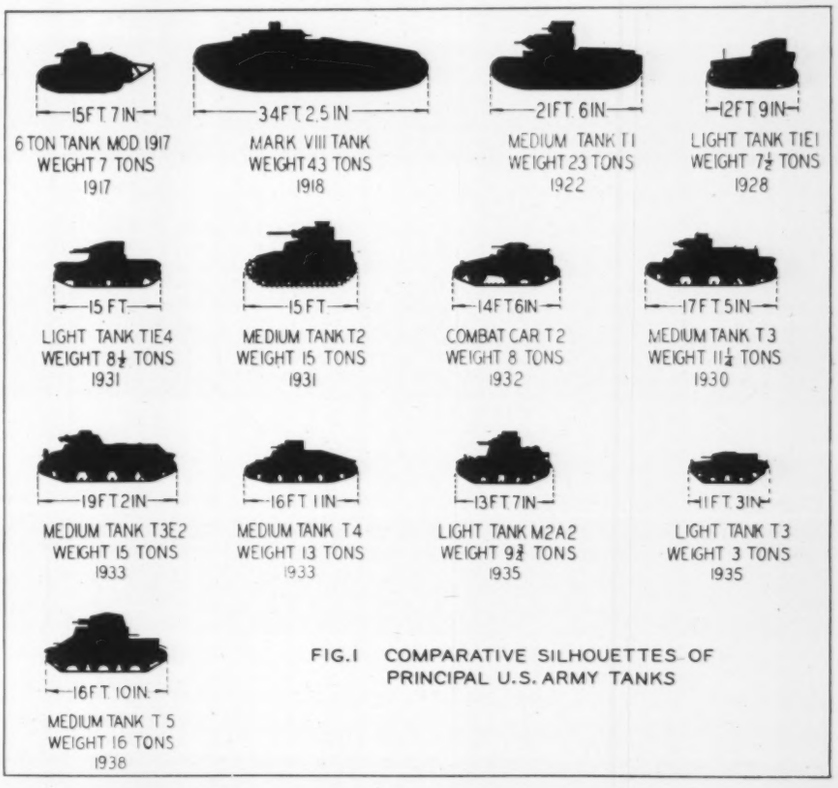

FIG. 1 COMPARATIVE SILHOUETTES OF PRINCIPAL U.S. ARMY TANKS

Presented at the first annual A.S.M.E. Day meeting, Pittsburgh, Pa., April 23, 1940, of the Pittsburgh Section, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed.

This article expresses the personal views of the author and does not necessarily reflect War Department policy on the subject.

FIG. 2 U. S. ARMY COMBAT CAR T4 DESIGNED IN 1933
(Weight = 19,240 lb; length = 16 ft 1 in.; height = 6 ft 7 in.)

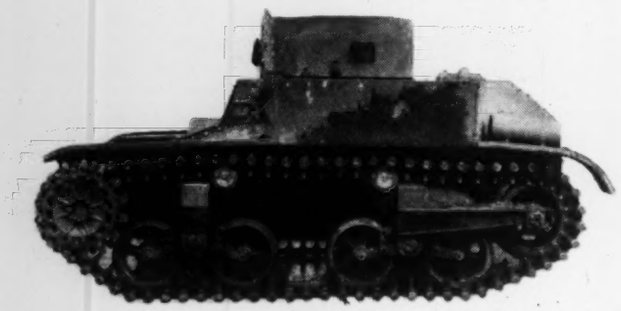

FIG. 3 U. S. ARMY COMBAT CAR T5 DESIGNED IN 1933
(Weight = 13,520 lb; length = 12 ft 9 in.; height = 6 ft 6 in.)

using services in the field which have dictated the development of mechanized equipment. However, in a few cases it will be necessary to refer to early developments and experiments.

EARLY TANK DEVELOPMENTS

After more than five years of experiments on various tanks carried out by the U. S. Army, there appeared on the scene in 1930 a tank which changed the entire conception of so-called "high-speed tank" performance. The Christie tank, developed and built by J. Walter Christie, embodied two principles which were entirely new to tank design. The first feature, that of convertibility, permitted the removal of tracks and the movement of the vehicle over the roads under its own power on wheels, with a tremendous saving of wear and tear on mechanism and highway. The other feature was the individual wheel suspension of great flexibility (a total individual wheel movement of 24 in.) which permitted hitherto unheard of speeds across country. With a horsepower-weight ratio of 30 hp per ton, speeds of 45 mph when operating on tracks across country were possible.

Not to be outdone by an outsider, the Ordnance Department designed and built the combat car T2 during 1931. Faulty weight distribution, which gained for it the nickname of "Droopy Drawers," and a 17-hp per ton power ratio gave it unsatisfactory performance. The chief contribution of this vehicle to progress was the fact that it was the first to employ the air-cooled radial engine for motive power. However, both the Christie and the Ordnance Department tanks failed to come up to expectations.

The cavalry, which had been struggling with four Christies since February, 1932, wanted to be supplied with its then authorized strength of 56 combat cars. The Christie and the Ordnance T2 were out of the question and the T3 had been killed on the drafting board by the adoption of differential steering and other obscure complications. In 1934 there came out for test, with high hopes of all, the combat car T4, shown in Fig. 2, employing the Christie suspension and convertible characteristics, needle-bearing, short-pitch track, and a unit power plant embodying an air-cooled radial engine, heavy-duty transmission, and differential steering. Weighing more than nine tons and with a 21-hp per ton power advantage, the performance was not up to Christie standards but was considered satisfactory if greater reliability could be assured.

Before this combat car could be produced for the using services, the War Department imposed a 7-ton weight limit on cavalry vehicles, causing the designers to start work on combat car T5, shown in Fig. 3. This tank was a radical departure in many ways. First, it was a full-track, nonconvertible vehicle, while heretofore it had been felt that for strategic mobility the cavalry combat car should be convertible from track to wheel. Second, it employed a volute-spring suspension. To understand this type of spring, one should consider a strip of steel coiled as is a conical paper of pins. Compression of this spring in the direction of the axis of the cone is also accompanied by internal friction between the layers of the coil creating a damping or snubbing action. This suspension assembly of two articulated rubber-tired wheels and two volute springs is known as the "bogey." Third, this car had a short pitch, rubber-bushed track, air-cooled radial engine in rear ("souped" up 50 hp more than the one in the T4), and a differential steering and transmission unit in front. This short-coupled, chunky little buggy had a 37-hp per ton power advantage and a speed of 45 mph, and handled like a polo pony. Because of the double turret this car was immediately dubbed "Mae West."

The feud was long and bitter between the proponents of the T4 and T5 combat cars. During a six months' test, the needle-bearing track of the T4 broke down because of inability to seal the bearings effectively and was replaced by a rubber-bushed track; the T5 track guides broke down and had to be replaced by sturdier ones. At the end, however, the T5, with certain modifications and a single turret, was adopted because of its light weight, superior power-to-weight ratio, and comparatively low cost.

Shortly after design started on the combat car T5, work was also started on the light tank T2. This tank had the Vickers-Armstrong articulated leaf-spring suspension but otherwise was identical to the combat car T5 whose tests so clearly demonstrated the superiority of the volute suspension that this type was installed on the T2 tank which then became the T2E1, shown in Fig. 4.

While the cavalry was weighing the relative merits of the T4 and T5 combat cars, the infantry decided to adopt an assortment of T2E1 light tanks and T5 combat cars with double turrets, as their light tank, and the T4 combat car with two different types of turrets, for their medium tank. Before production had started on these various models the rubber-block track shoe was developed and incorporated in the combat cars and light tanks. This shoe consists of a metal link, to each side of which is bonded a rubber tread. This gives better traction, quieter movement with less vibration, and less wear on the road surface. The block is so constructed that when one side becomes worn the block may be reversed and a new tread surface put in use. This rubber-bushed, rubber-block track is giving, consistently, 3000 miles' service in the field.

TANK CONSTRUCTION DIFFICULTIES

A difficulty arose in production of these combat cars and tanks. The test or T models were all made up in soft plate to

save expense, and joints were welded. In production it was found that the character of the hardened armor plate was so altered by welding that the welded area became vulnerable to gunfire. It is interesting to note here that Germany did not make this discovery until her tanks came under fire in Poland. Official German reports state that the majority of instances of tank hull penetrations were in the welded joints. This discovery necessitated the use of rivets and butt plates which increased the weight of the vehicles and delayed production. A special rivet was developed with a hardened flat head and a soft nose. Finally, in 1935, production started down the assembly line at Rock Island Arsenal. As is always the case, the production model was heavier than the pilot ($9^1/_2$ tons) which reduced the power-weight ratio to 27 hp per ton, and also exceeded the War Department weight limit.

However, these production combat cars and light tanks, identical except for the turret arrangement, were standardized as the combat car M1, light tank M2A1 (single turret), and light tank M2A2 (double turret).

MEDIUM-TANK DEVELOPMENTS

In 1936, work was started on the design of medium tank T5. (See Fig. 5.) The light tanks and combat cars had proved so satisfactory in service that the medium tank was developed along their lines. In order that some phases of development work could be carried on while the designs of heavier power plant, transmission, and running gear were being worked out, the phase I tank was built early in 1938, incorporating the production engine, transmission, and running gear of the light tank. The phase III tank was completed last year after development of power plant and power train which was called phase II. Similar in appearance to the phase I, it was powered with a 400-hp air-cooled radial engine, had a heavier transmission designed to handle the increased power and weight, and a broader track shoe to give flotation to the increased weight. This model proved satisfactory in tests, and though it exceeds the 15-ton limit, its standardization has been approved and it is now in production as medium tank M2.

At present, then, the standardized vehicles in the U. S. Army are the combat car and light tank, which are essentially identical, and the medium tank which is similar in design though necessarily heavier in construction, all of which have exceeded War Department weight limitations.

USE OF TANKS

Up to this point the Army was so interested in getting a tank that would operate consistently that it lost sight of the use to which these vehicles would be put. The combat car, with its reconnaissance and support elements, was designed to be used on a wide end run, striking an exposed flank or deep into the hostile rear, quickly and unexpectedly. This type of action requires extreme mobility and anticipates encountering very little organized resistance. To keep the weight down and preserve mobility, therefore, these cars carried armor protection ($^1/_4$, $^1/_2$, and $^5/_8$ in.) against small arms (rifles, machine guns, and pistols) only. Furthermore, the cavalry, operating independently, must be prepared to meet attack from any direction, hence the need for the large, two-man turret with high-speed traversing gear that enables its guns to be brought into action in any direction.

The infantry tank is a supporting weapon of the foot soldier. Its normal employment is running interference on a line play; in other words, it crushes resistance which has been delaying the advance of the infantry soldier. In this role it generally encounters strongly occupied and organized resistance. Operating in support of other troops, its flanks and rear are generally protected and hence observation and extreme flexibility of

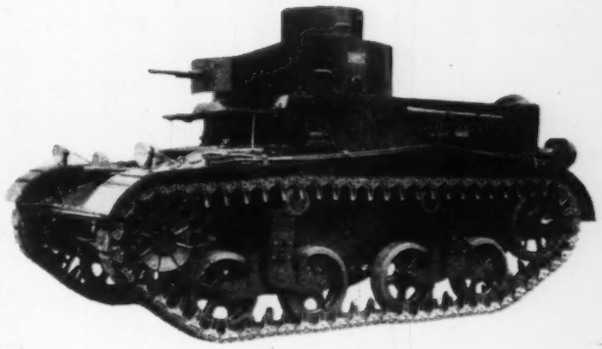

FIG. 4 U. S. ARMY LIGHT TANK T2E1 (M2A1)

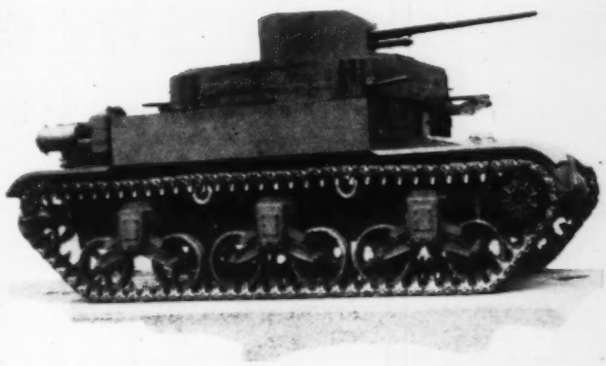

FIG. 5 U. S. ARMY MEDIUM TANK T5 (PHASE I) DESIGNED IN 1937 (Weight = 30,000 lb gross; length = 16 ft 10 in.; height = 8 ft 9 in.)

turret are not so essential. The manner of employment of the two types of tanks is to launch the medium tanks first to search out and crush the anti-tank defenses. For protection they are heavily armed (one 37-mm anti-tank gun and six caliber .30 machine guns) and armored ($^1/_4$ to 1 in.). Following the medium tanks, a swarm of light tanks crushes the remaining resistance. Expecting this resistance to be principally small-arms fire, the light tank, like the combat car, carried only protection for that, a maximum of $^5/_8$-in. armor.

Experience in Spain, however, showed that the medium tank could not account for all the anti-tank guns, many of which remained to pick off the light tanks. This and the introduction of land mines as a measure of anti-tank defense has demonstrated the need of heavier protection on light tanks.

Difficulties on these first combat cars and light tanks were numerous but generally minor. A few that were encountered by the cavalry at Fort Knox will be described because of the author's familiarity with them; the infantry troubles generally paralleled those of the cavalry.

As the weather became warmer in the late spring of 1936, "vapor lock" raised its ugly head and a five-gallon desert water bag became part of every car equipment. Fan and engine cowlings were modified, additional air intakes and outlets were cut, carburetor jets were changed, gasoline lines and pumps were insulated, 78-octane gasoline, for which the engine had been specially modified, was replaced by 92-octane fuel, but though each change seemed to bring some improvement, the trouble was never really licked until a by-pass from the fuel pump and the carburetor line back to the fuel tank permitted the circulation of gasoline through the lines even when the carburetor float valve was closed. The 92-octane gasoline was retained, however, complicating the supply problem until this year

FIG. 6 U. S. ARMY ARMORED CAR T11E1 (4W—4WD) DESIGNED IN 1934 (Weight = 12,900 lb gross; length = 15 ft 3 in.; height = 7 ft 4 in.; wheel base = 9 ft 8 in.)

when the cavalry has been permitted to experiment with commercial-premium ethyl (82-octane) fuel for use in all gasoline engines.

The next major catastrophe did not appear till the start for maneuvers in Michigan early in August. The staff planned on making the 400-mile march in two stages. Starting on a boiling hot day, about 75 miles out bogey tires began to explode. Investigation disclosed that most of these tires were of a certain make and hence it was concluded that that particular rubber formula was not suited for the service. The next day, however, another brand began separating from the rim and peeling off in large chunks. By that time all the spares had been used up so the crews stopped long enough to take their axes and chop the rest of the tire off and drive on on the rim. This latter trouble continued in a lesser degree for nearly a year before a satisfactory rubber compound and rim shape were developed.

These maneuvers were also exceedingly hard on transmissions, which seemed to fail after about 1500 miles of service. This baffled everyone until it was found that lint from the steering bands was clogging the screen of the circulating oil pump in the transmission and differential assembly. Hard starting when hot or when very cold is a characteristic of this engine that has not yet been licked. Generally, the engines are left idling unless it is known that they will be shut down for ten minutes or longer. Various heaters have been tried for cold-weather starting but "oil dilution" has given the best results.

The elasticity of the track owing to the give in the rubber-bushed joints caused some throwing of tracks at first, but the drivers got the technique of keeping them on and only a greenhorn loses a track now. These early cars were called "Jeep Wagons" by the soldiers but that name has generally given way to the title "Hell Buggy," which their adversaries in maneuvers originated.

RECENT CHANGES IN TANKS

When procurement plans for additional vehicles came up in 1938, several changes in design were made. To improve riding qualities, the wheel base or "bogey base" was lengthened about a foot, the rear idler extended beyond the hull, and the truck lengthened. This not only gave a more stable gun platform but also gave better flotation. The cooling fan was redesigned so that its power consumption was reduced from 80 hp to 40 hp. Accessibility to engine and other parts was greatly improved. At this time also the question of heavier armor came up and the cavalry rejected it in favor of mobility. The infantry, however, chose the heavier plate and a 16 per cent performance loss.

Development continues on vehicles in service. The standard transmission is constant-mesh in the two highest gears. Experimental transmissions, some employing constant-mesh throughout and others synchromesh, are undergoing test. The most interesting test, in the opinion of the author, is that on the 9-cylinder, air-cooled, radial Diesel power plant.

These vehicles, though extremely sturdy, have certain undesirable characteristics. The drive shaft from the engine to the transmission passes through the center of the fighting compartment at a height of about two ft. This shaft is enclosed in a tunnel but it takes up a lot of valuable space. Models now on order for the cavalry drop the shaft, through a transfer case at the end of the engine crankshaft, to the floor and bring it in to the modified transmission on the extension of the pinion shaft instead of the countershaft as before. A false floor under which ammunition will be stored gives an unobstructed platform in the fighting compartment. The turret is being improved with much-needed seats and safety belts for gunners, and it is expected that one or two experimental electrically rotated turrets will be tried.

The cruising radius of 100 miles for the gasoline-powered models is insufficient, but the vehicle is so compactly built that no additional fuel space is available. The Diesel units, however, with the same fuel capacity cruise over 200 miles, and 70 Diesel tanks are in the next order for delivery this fall.

COST OF TANK OPERATION

The tanks cost 80 cents a mile to operate. The tracks cost $1100 a pair with a life of about 3000 miles, and a $400 retread adds, optimistically, 3000 more miles. This gives a total of 6000 miles for $1500, or 25 cents a mile for track maintenance alone. Add to this the fact that previous experience with convertible-type vehicles has demonstrated that fuel consumption for track operation is double that for wheel operation, together with a corresponding variation in engine and transmis-

FIG. 7 U. S. ARMY HALF-TRACK TRUCK T5 DESIGNED IN 1934

sion wear and tear. It is a conservative estimate that this operating cost could be cut in half for wheel operation of a convertible type. On the other hand, the convertible feature is expensive, heavier, and entails some time (about ten minutes) in a change-over which may be the cause of an outfit's being caught either on wheels or in process of changing when it should be ready to take off crosscountry in a sudden attack or to seek cover in near-by woods.

It may be that the reduction of track cost per mile and of track power loss, by further development, will solve the problem, and again it may not. Experiments with a continuous-band rubber track have not as yet proved entirely satisfactory. The abortive convertible combat car T7, which is really the series M1 combat car with the convertible feature added, is two tons heavier, considerably more expensive, and not satisfactory in performance. The War Department, with over 400 combat cars and light tanks in operation, has met the present situation by directing that all strategic and administrative marches of more than 50 miles will be made by rail. The attendant delays and difficulties of obtaining rolling stock, locating suitable loading and unloading points, and lashing the cars down are obvious. The cavalry shipped its track-laying equipment to Plattsburg by rail last summer and south in May, 1940, the same way. The cavalry still wants inherent strategic mobility without unnecessary wear and tear to the vehicle.

Summarizing, the developments in the tank and combat car, so highly specialized, have tended to increase mobility by increasing the power-weight ratio and incorporating a more flexible suspension. The lightweight, compact, powerful air-cooled, radial engine is chiefly responsible for the former and the volute suspension for the latter. Effort has also been directed to increase reliability and decrease cost of maintenance and operation. Constant-mesh transmissions, controlled-differential steering, and the rubber-bushed, rubber-block track have contributed to this. Certain standardization of design and interchangeability of parts between different models have not only reduced manufacturing cost but also have simplified maintenance.

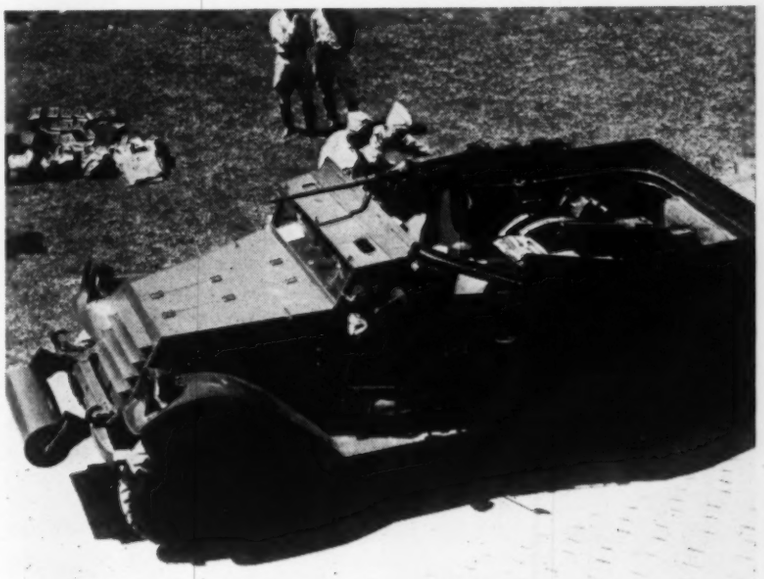

FIG. 9 U. S. ARMY SCOUT CAR M3A1 ADAPTED FROM M3 MODEL

FIG. 8 U. S. ARMY SCOUT CAR M3 DESIGNED IN 1937
(Weight = 9960 lb gross; length = 16 ft; height = 6 ft 9 in.; wheel base = 10 ft 11 in.)

ARMORED-CAR DEVELOPMENTS

Armored car T11 was designed in 1932, and after some experimentation and alteration in cooling the engine, which was mounted in the rear, was adopted as the standard armored car M2. (See Fig. 6.) Six were procured and are now in service with the First Cavalry Division at Fort Bliss, Texas. This car, in the opinion of many, is the best reconnaissance vehicle yet produced. With a four-wheel drive, short wheel base, center-mounted turret, and engine in rear, its performance is excellent.

Paralleling the armored-car development was the development of the personnel carrier and artillery prime mover, to carry the combat car's supporting elements. The reader might recall the publicity which heralded the crossing of the Sahara Desert in 1930 by a group of Citroen half-track trucks. One of these was obtained for test in 1931 by the U. S. Army and from it, in 1933, the half-track T1, later improved as the T1E1, was developed as a cavalry personnel carrier and 30 were produced for service test. The similar, though heavier, T5 was developed a year later as an artillery prime mover and 24 were issued for service test.

The chain-link and rubber-pad tracks with which these vehicles were first equipped were unsatisfactory because of short life and power loss. They were replaced by continuous-band rubber tracks which have performed very satisfactorily. The cross-country capabilities of these two half-tracks were disappointing because the front wheels, which were not powered, would not climb over comparatively small obstacles. Another unsatisfactory characteristic of these vehicles is their lack of armor protection for their crews who frequently must come into the fire-swept zone before dismounting. These T1E1 personnel carriers have just passed into reserve, but the T5 prime movers are still in service. (Fig. 7.)

THE SCOUT CAR

The scout car was originally conceived as a light, fast, reconnaissance vehicle to augment and extend horse cavalry reconnaissance. Various cut-down, bucket-seat "jalopies," improvised by different organizations, began to appear in maneuvers as early as 1928. But it was not until 1932 that the idea was dignified by recognition as an ordnance project, scout car T1. This was a stripped Pontiac chassis equipped with oversize balloon tires, carrying a light machine gun and limited armor protection. When next heard from in 1933, the scout car had grown into the T7 model, a four-wheel-drive, fully armored vehicle weighing $4^1/_2$ tons, of which 77 were produced for the cavalry as scout car M1. Service tests developed some weaknesses and in 1935, twenty-four M2 scout cars were produced and sent to Fort Knox for artillery reconnaissance and command vehicles. Both these cars have pedestal gun mounts which are limited in their usefulness. A rail mount was developed from the Air Corps flexible gun mount and proved so successful that it was incorporated in the design of the M3 scout car (Fig. 8) in 1936. This rail encloses the entire crew compartment and carries three skate gun mounts which may be swung to any point on the rail and locked there. It was while this car was in the process of development that the Thirteenth Cavalry was mechanized, and it was decided to equip this regiment with the M3 scout car for both reconnaissance and personnel carrying purposes.

The M3A1 scout car (Fig. 9) is merely an improved M3 giving more room and a better seating arrangement and a front roller that is a big help in crossing ditches and the like. Production on these cars started last fall and they have been issued to the First Cavalry as replacements for the M1 armored cars and T1E1 half-track trucks. They are also being issued to the two recently reorganized reconnaissance regiments, and to the cavalry reconnaissance squadrons now being organized in the National Guard. Two of these cars, just received at Fort Knox for test, are equipped with commercial-truck Diesel engines; one Buda and one Hercules.

Now, just as it looked as though the scout car had run the armored car and the half-track out of the picture, a new half-track with a scout-car body is coming out for test. (Fig. 10.) The running gear of this car involves volute suspension similar to the combat car, though lighter, and with power on the front wheels and no doubt, by now, a front roller. Its suggested uses are as a reconnaissance car, personnel carrier, or an artillery prime mover.

DIESEL-ENGINE EXPERIMENTS

The increasing experiments with Diesel power are gratifying. The Diesel possesses several distinct military advantages over its gasoline cousin. Lacking electrical ignition, the Diesel does not require radio shielding and the attending continuous maintenance problem, which is considerable when one out of every three combat vehicles is equipped with two-way radio. Diesel fuel, being less inflammable than gasoline, reduces the fire hazard which is something to think about when men are cooped up in a combat car with someone shooting at them or heaving hand grenades their way. The Diesel will stand up under conditions which would stall a gasoline engine, which often means the difference between keeping rolling on the battlefield or stopping to let the enemy take careful aim while the crew cranks an engine. Last but not least is the question of fuel economy. The Diesel, gallon for gallon, consumes just half as much fuel as the gasoline engine.

CONCLUSION

The days of experimental mechanized forces are over. In ten years the U. S. Army has developed vehicles, tactics, and doctrine. The equipment is now the equal of any in the world. It is now ready for expansion. A force of this nature cannot "spring to arms overnight," since the procurement of vehicles alone will take the better part of a year, while it will take months of training to turn out skilled drivers, mechanics, radio operators, gunners, and the score of other technicians needed.

The mechanized troops, which are available at the outbreak of a war, will be the only ones to be in action for the first eighteen months of fighting. Very shortly the present mechanized brigade of 2500 men and 600 vehicles will probably be expanded into a division of close to 10,000 men and 2000 vehicles.

[Just as this article was being put into type, the War Department announced (July 1) the formation of an Armored Corps of two armored divisions similiar to the mechanized division mentioned in the preceding paragraph. The mechanized brigade at Fort Knox began expansion as the First Armored Division on July 15, and the Second Armored Division began its organization around tank elements stationed at Fort Benning, Ga., on the same date.—EDITOR.]

FIG. 10 U. S. ARMY HALF-TRACK ARMORED TRUCK T7 FOR CARRYING PERSONNEL
(Weight = 12,300 lb gross; length = 16 ft 9 in.; height = 6 ft 7 in.)

MANAGEMENT *and* ENGINEERING EDUCATION

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MANAGEMENT has been an accepted subject of college and university study for more than a generation. As engineers know, "scientific management" had its origin near the turn of the century in the work of a distinguished engineer, Frederick W. Taylor. The significance of the so-called Taylor system lay in the then novel thesis that problems in management, like problems in engineering, lend themselves to solution by scientific methods.

In the years following publication of Taylor's early experiments a number of distinguished engineers made important contributions to management study, management courses sprang up in colleges of engineering, and collegiate schools of business sought out men with engineering training to develop similar courses. Concurrently with their academic work, teachers of management were frequently practitioners, either as consultants or as staff members of industrial concerns. Meanwhile the literature of management was being enriched by numerous studies to which engineers were major contributors. The study of "Waste in Industry" put out by the Federated Engineering Societies in 1921 is a notable example. Results in the field of management, obtained by engineering methods and techniques, greatly influenced the work of others than engineers, both in industry and on the faculties of leading schools of business.

As management courses have developed, it has become clear that to regard study of management as a branch of engineering is to ignore many fundamental differences between the two types of discipline, and engineering educators have at times voiced considerable misgiving concerning management curricula. At the same time definite limitations in the engineering approach to management, as expounded by Taylor and his followers, have become manifest. These circumstances suggest the wisdom of reappraising relations between the two fields as subjects of higher education. It is well, also, to consider anew the disciplinary values inherent in management study, the objectives of such study, and finally, the reasons which have made it seem appropriate for standard engineering schools to offer systematic management instruction.

MANAGEMENT STUDY AS DISCIPLINE

From the nature of their subject matter, management courses cannot conform closely to the pattern of technical courses in engineering. Study of management must of course employ scientific method, but its data are drawn largely from social phenomena for which analytical procedures diverge, in essential regards, from those of physical science. Difference in subject matter and in method need not, however, imply any difference in rigor of requirements or of discipline. The task of science, in management as elsewhere, is to analyze and classify data, and from uniformities discovered to derive laws or trends which may become new points of departure for study and for action.

Management courses, then, are like engineering courses in that they must utilize scientific method, but are unlike them in the nature of the data with which they are chiefly occupied. Although management must operate machines and process materials in running an enterprise, its chief problems lie in adjusting activities of human beings, individually and by groups, to the demands of the particular enterprise. Much of the basic material with which management study is occupied is in the form of mass data which can be analyzed by accepted scientific methods; but important human factors enter, even when study is directed toward inanimate materials.

The intermingling of physical and human factors is well illustrated by questions pertaining to the supplies a concern may need. Methods of geology and geography can be used to ascertain the physical supply of raw materials. Managers have the same access as engineers to standardized tests of materials, and highly accurate statistical data concerning different market items can be used as guides in purchasing. However, the knowledge of materials which physical science and mathematical statistics thus make available is of little use to management except as these facts are interpreted in the light of many human factors which condition use and availability of those materials.

The mental picture which the idea of a market for a particular commodity may call forth is directly associated with the physical commodity itself, but the expression "supply and demand" which designates the basic elements in a market is essentially a human concept; in substance the market for a commodity is a joint result of work some men do to make the commodity available and that other men do to acquire something to exchange for it.

Recording and measuring activities, through which supplies of commodities are forthcoming to meet demand, and demand stimulated to absorb supply constitute major items in the study of markets. Accurate knowledge of facts needed for judging present and future relations between supply and demand is so important that business concerns utilize elaborate statistical services to enable them to predict market conditions. While such predictions do not attain the precision of results achieved in physical laboratories, they nevertheless constitute definite guides to action.

The ever-present human element introduces into units of management study an unavoidable factor of variability and narrows the limits for controlled experiments. Numerous unpredictable contingencies frequently restrict conclusions to varying degrees of probability, and definite laws are few. Management, to be sure, has constant use for engineering techniques, and it employs mathematical methods in studying many types of data, but its procedures supplement those of engineering and seldom duplicate them.

Parallel to its occupation with mass statistics, management itself is under constant necessity to use data which cannot be subjected to mathematical analysis. On its human side, management is in part psychology, individual and group, in part economics, in part finance, in part politics, and in considerable part, history. Management has occasion to tap varied sources of knowledge, and subject matter from many fields may have appropriate place in management study; accordingly, diverse methods may be used in pursuing its educational aims.

Since technically exact engineering methods apply only to limited phases of the problems management has to solve, effort to make management courses in an engineering school approach the pattern of technical courses is likely to be a futile gesture and to impair standards rather than to strengthen them. When basic differences between the two types of discipline are recognized as they are carried on side by side under equally exacting standards, each is sure to enrich the other.

To summarize, management study is occupied with subject matter ranging from exact and relatively constant engineering data to the fluid situations of a changing social scene. As discipline, it has the task of selecting study materials which appear best suited to its objectives, of utilizing for analysis scientific methods and techniques appropriate to the respective materials, of maintaining suitable balance between different types of study, and finally, of directing results toward sound educational goals.

SCOPE AND OBJECTIVES

The scope of subject matter to which management study is addressed has been greatly extended in the years since Taylor first applied scientific management to the output of labor in factories. Labor output was soon found to be so closely related to planning, scheduling, and controlling factory production that a scientific study of output entailed an equally scientific study of these elements. Other items of administration such as maintenance, office management, and sales were later subjected to scientific analysis. Although in recent years scientific study has been extended over nearly all phases of internal management, management courses have as yet given but fragmentary attention to the external factors—economic, financial, political, psychological, and social—by which management policies are conditioned.

Management is concerned with networks of relationships which it has the task of coordinating so as to advance the purposes for which an enterprise exists. Such coordination applies moreover not only to different activities and personalities but to different types of knowledge, and to different instruments and mechanisms which management employs. Finally, the problems of organization and direction which confront management are constantly changing as technical, industrial, and social changes compel new adjustments. The types of discipline which must be utilized in analyzing subject matter are as varied and changing as the subject matter itself.

The basic aim of scientific method in all phases of management study is objective search for significant truth. Scientific study involves division and classification for relating the parts of a subject to one another and to the whole. The principle of classification found most fruitful follows the line of function. Functions to which management study is chiefly directed are those common to most types of enterprise. Concerns ordinarily produce a commodity or a service; production thus is obviously a function of management. But production is a divisible function. Study and planning required to build and operate a plant, to keep stores of materials and equipment, to route material through the plant—all are production functions characteristic of a great variety of enterprises. These and related functions comprise the general subject "production management." Similarly, services associated with the disposition of products are brought together under "distribution" or "marketing."

Production and distribution are primary functions of a business enterprise. But there are also secondary functions. In order that production and distribution may be carried on effectively, numerous service functions must be maintained. It is essential to record transactions, to analyze and interpret records, and to apply conclusions to which such interpretations may lead. The group title of these activities is "Control" with accounting and statistics as the most essential control services. In order to operate effectively, every division of an enterprise must be competently manned; and so, many concerns have segregated personnel management as another service function. Similarly, in more complex concerns, finance, law, engineering, and sometimes insurance, and other specialized services are set up as divisional management functions.

Data drawn from functional activities constitute essentially the internal subject matter of management study. But management also has external problems. Appraisal of environmental conditions and particularly of changes in them, as these changes affect the stability and success of an enterprise, is one of management's crucial tasks. Technological change and realignment of social forces make it peculiarly necessary, in formulating and executing policies, for management to exercise industrial statesmanship over a wide variety of external circumstances.

For purposes of analysis, it is essential to divide management into its parts and to study basic management functions, such as production, distribution, accounting, finance, and personnel. Similarly, it is necessary to consider specific external factors. However, the end result toward which management study is directed is not highly specialized knowledge of these detachable fragments, but a grasp of management as a coordinated whole. Adjustment of the forces which determine the success of an enterprise, and the relationships between internal and external forces present problems of such magnitude that in many aspects they even challenge the existing social order. Foundations for sound statesmanship concerning them, as they may develop in the future, can only be laid in sound education today. Management education, therefore, has the task of maintaining suitable balance between internal and external factors, and of directing study toward grasp of essential management problems in their entirety.

The need to emphasize an over-all viewpoint is enhanced by the fact that subject matter of management study is frequently inherited from courses directed largely toward training specialists in divisional subjects. From the standpoint of management study in a college of engineering, it is essential to re-examine the content of even such well-established subjects as accounting, finance, and factory management, in order to direct study definitely toward general management objectives. In less standardized subjects like business organization, marketing, labor problems, and economics, need for a purposeful selection of potential materials is even greater.

By way of illustration, accounting and statistics are essential tools of management and as such they are indispensable in a management course. Obviously, management students need opportunity to master the principles which apply to keeping, interpreting, and using records, but it is not essential for them to master all the details and specialized knowledge needed by a certified public accountant or a professional statistician. If accounting and statistics are studied primarily as ends in themselves rather than as essential tools of management, their significance from the management angle is likely to appear in distorted perspective.

The danger that tool subjects, of which accounting and statistics are examples, will be unduly expanded, is enhanced by the fact that such subjects are usually taught by teachers who have a major interest in the subjects as specialized branches of knowledge, and they naturally tend to overemphasize techniques which have but minor significance for management. In order that general objectives of management study may be realized, the scope of specialized study needs to be fixed with a view to such balance between the several elements of a course that, jointly, they may be most effective in preparing students for management competence and leadership.

In setting up management curricula, not only is it essential to keep the tools and functions of management coordinated with main objectives but it is equally essential not to neglect new tools and changing relationships between functions. Social, political, and technological changes are constantly shifting emphasis from one phase of management to another and giving rise to problems which require new viewpoints and new techniques for their solution. An eloquent case in point is the emergence of personnel as a major management function. Of necessity this requires the development of techniques for applying scientific methods to personnel problems.

One of the ramifications of personnel management carries it into the field of industrial relations. With the expansion of national organizations of labor, the subject of industrial relations has come to embody in recent years one of the most significant items in management. Policies, practices, and procedures through which a concern carries on its relations with groups of employees and their representatives, under present conditions, have a larger influence upon the long-time results of management activity than almost any other single item of policy. Representatives of employers and of employees require not only training and experience but a constantly maturing competence if needless misunderstanding and strife are to be avoided. In general, epochal changes which have occurred in labor organization and in legislation on collective bargaining have greatly shifted emphasis in management as between material and human elements.

Industrial relations are closely interlocked with other phases of management, especially with technology. Scientists and engineers create new products, new processes, and new methods for doing work for which management is responsible. As a result, jobs disappear and new jobs are created. Because, for the long pull, jobs created overshadow those that disappear, science is constantly adding jobs—adding to the number of people whom the resources of the earth can sustain, and raising the potential level of human well-being. But hitherto science and engineering have not been greatly concerned with the lags that occur between the disappearance of old jobs and the availability of new ones, or with the adjustments which individuals have to make in going from the old to the new. Even though every job eliminated were at once replaced with another, which of course is not the case, the new jobs frequently demand quite different qualifications from the old ones. When displaced workers experience a period of unemployment and possible deterioration and later find employment only in a different or basically altered occupation, difficulties of adjustment are multiplied and costs are created which the community and ultimately business must carry. In any case, human wastage which too often occurs in the shift from one technique to another is well within the scope of management study.

In order to overcome the backward pull of inertia and to maintain a setting conducive to healthy growth, it is essential to give place in courses of study to some subjects before they reach maturity. To be sure, a relatively new subject may at times be given more space and emphasis than it will prove to merit, which means the newer and older subjects alike require constant reappraisal. Space and emphasis, accorded to different subjects, should always have chief reference to their current and anticipated future significance rather than to the position they have occupied traditionally. Except for historic interest, subject matter which has become outmoded through evolutionary change should be discarded.

The fact that management is an art which touches upon nearly every aspect of living accentuates the responsibility for purposeful selection of materials whatever the type of school. But in colleges of engineering, the need for perpetual inventory and reappraisal of subject matter is enhanced by the major premise upon which the course is authorized. This premise accepts that discipline in physical science is valid and important for the study of management. Such discipline cannot be adequately realized unless the study of physical science and its applications are carried far enough to develop scientific habits as they may apply to management problems. Some students acquire these habits more quickly than do others; but as regards the practical problem of setting up a four-year curriculum, any reasonable minimum of science and engineering study will inevitably compress the time and energy available for management proper into a smaller compass of college hours than would normally be assigned in a collegiate school of business.

In summary, the objectives of management study in a college of engineering are to lay foundations for competence and leadership; its scope must be as broad as management itself. Competence, of course, entails knowledge of essential management tools, but beyond that it involves understanding of relationships between functions and ability to appraise their individual and joint significance in a total management picture. Competence does not imply mastery of all the skills which management may utilize, much less of the whole body of knowledge upon which those skills rest. Managers have constant occasion to assign specialized tasks to specialists. Balanced judgment in doing this and in appraising results of analysis in specialized fields may easily be warped when the manager himself is a master in one of those fields. Ability to comprehend analytical results in whatever field is, of course, indispensable.

Management leadership implies not only understanding but decision; and judicious decisions must balance the internal and external relationships of particular situations. By selection of problems for study which involve an interplay of such internal and external forces, and which call for decision, college work in management can lay foundations for a continuing growth in which knowledge and competence, enriched by experience, may ripen into leadership on whatever plane of management particular talents find their level.

SHOULD ENGINEERING SCHOOLS TEACH MANAGEMENT?

Although scientific management was initiated by engineers, management study has centered largely in collegiate schools of business, and it is pertinent to ask why curricula of engineering colleges should be encumbered with it at the possible risk of a harmful scattering of effort. Difficulties in the way of realizing both its objectives and its potential disciplinary values and of giving it adequate scope in a college of engineering cannot be minimized.

If business schools had unequivocally achieved the seasoned professional status of schools of law and medicine, or if management study rested squarely upon particular basic sciences, as medicine has rested upon biology and chemistry, the case for giving it place in a college of engineering might be dubious, but analogies with other professions are at best imperfect.

Solution of management problems in the typical case is largely influenced by engineering factors, while at the same time the operation of these factors is conditioned by human reactions. Cases in point occur in connection with changing technology. Frequently it is desirable to introduce new techniques tentatively, in order to subject engineering factors to operating tests before changes are definitely installed. Equal caution is needed in respect to human factors. Ill-considered installations may easily give rise to costs which more than offset economies. Inadequate attention to reactions of employees, as previously indicated, may result in impaired morale or even in industrial strife. Looking beyond the individual plant, neglect of displaced workers, especially when changes in technology are rapid and widespread, may add to the cost of public and private assistance, aggravate social unrest, and in numerous

hidden ways create costs which business as a whole must bear. Obviously, development of basic principles which can be used as guides in inaugurating new techniques is within the scope of collegiate study in the field of management; engineering colleges are in an exceptional position to pursue such studies. Management and engineering are inseparably interwoven, and in the interests of both, there is a strong case for tying them together in education as they are tied together in actual affairs.

From the standpoint of students, reasons for teaching management in a college of engineering are twofold: In the first place, such colleges have responsibility for general as well as professional education; secondly, understanding of management is essential to the work which engineering graduates are called upon to perform. Management is so large a factor in the current scene that no type of education may ignore it. In the case of engineering, study of management offers rich opportunity to stimulate intellectual curiosity and to promote understanding of the world. Its value is inestimable in preparing students for both civic and professional leadership.

Engineering is not a cloistered profession; in large measure it functions in the market place. As a result, engineering graduates in the typical case enter positions in which their work is so largely conditioned by its management setting that awareness and understanding of management requirements are essential to success. This is true even in respect to such nonexecutive functions as designing and technical research, but more than half of the engineering graduates who have reached the age of forty have positions that carry important management responsibility; the percentage of these appears to be increasing. Engineer managers have too often revealed shortcomings in handling the human factors in their work which more attention to such factors in college might have forestalled, and it is pertinent to inquire how adequately we are now preparing engineering students for the tasks which engineers of their generation will probably have to perform.

Consideration of management problems need not be confined to courses which bear a management label. Many engineering teachers are especially alert to the significance of management problems and effective in presenting them. However, it may be doubted whether a subject as many-sided as management can be adequately taught unless its place in the curriculum is definitely allocated and instruction given by management teachers of mature competence.

Advancing technology has become, perhaps, the most impressive and significant factor in the relation of man to his environment. It pervades man's economic, social, and even his religious and cultural activities. So potent is the influence of technology upon civilization that it has become socially dangerous to regard achievements of applied science as ends in themselves or as objects of continued stimulation without regard to social consequences. Technical education is one of the most essential elements in present-day culture and it is socially necessary that it assume the responsibilities which such a status implies.

Management lies at the crossroads between technology and the social fields with which it is interrelated. Since management directs many of the forces by which human beings make their livelihood, and because its social implications are so far-reaching, the task of laying intellectual foundations for integration of management and technology is an important function of higher education. The social changes of our time have greatly emphasized this function and have added new reasons for including management study in engineering curricula.

Environmental and curricular conditions will usually determine the amount and in some measure the organization of management instruction. Schools in which engineering curricula include a considerable range of integrated work in social science may find it expedient to confine special work in management to those students who take a management option. Other schools may consider that need for management study applies to all engineering students and hence require a minimum of such study of all students. Colleges of engineering with a university setting can frequently extend their curricula by drawing upon other divisions of the university; when those divisions include a school of business, the engineering school will not usually find it necessary to set up special courses. Obviously, every institution must judge the need of its students for instruction in management from the vantage point of its own peculiar situation.

Forces which surround both engineering and management are highly dynamic, and the relationships involved are subject to constant change. Need to consider the most advantageous organization and content of management courses applies alike to engineering schools that have such courses, and to those that do not. Education can keep abreast of current needs only through constant reappraisal of its instrumentalities and its aims. Management courses constitute a recognition of interlocking relationships between management and engineering; in a changing age they help engineering education to discharge its social responsibilities.

IN THE ST. JOE NATIONAL FOREST

(Within easy distance of Spokane, Wash., where A.S.M.E. Fall Meeting is to be held Sept. 3–6, see pages 628–629.)

IS PSYCHOLOGY USEFUL?[1]

By DOUGLAS M. McGREGOR

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IT IS frequently my experience to be introduced to business or professional men with the comment that I am a psychologist. With minor variations, the subsequent conversation is likely to include the following comments: "What is the study of psychology good for? I took a course in psychology in college, but I fail to see that it has had any bearing upon the practical problems of my daily life. I remember studying the anatomy and physiology of the nervous system in great detail, and learning about a lot of experiments with rats in mazes and with humans who learned long lists of nonsense syllables. I remember studying theories of color vision, laws of attention, and the relationship between stomach contractions and hunger. But that is about all. I face hundreds of problems in the daily conduct of my affairs that are psychological in nature. At least they involve decisions concerning the how and why of human behavior. Has psychology gotten around to dealing with such matters yet? And if it has—if it is practically useful today to study psychology—what books shall I read? Can psychology offer anything more than Dale Carnegie's twenty-eight rules for influencing people?"

There are some psychologists whose reply to these questions would be that psychology still has little or nothing to offer concerning the practical problems of daily life. They feel that an adequate understanding of human behavior will be possible only after many more decades of laboratory experimentation, and that therefore it is presumptuous of the psychologist to offer advice concerning the practical implications of his present knowledge.

Moreover, it is the earnest desire of these psychologists to establish psychology firmly as a science on a par with physics and chemistry. Consequently, they tend to seek problems for investigation in which there is the greatest possibility of controlling the variables experimentally, and in which rather exact measurement is possible. They continue to confine their experimentation to rats learning mazes, to humans learning nonsense syllables, and to people experiencing hunger pangs, colors, or musical tones. It would seem to them foolhardy for the psychologist to attempt to study the problems that arise in the negotiation of a collective-bargaining agreement, or to try to find out why a particular foreman is unable to obtain the cooperation of his workmen. Such problems cannot be attacked "scientifically." Therefore they should be ignored until we know much more than we do today about the fundamental laws of human behavior as revealed in the laboratory.

Perhaps they are right. However, there are many psychologists with a different point of view. Gordon W. Allport of Harvard University, in his recent presidential address before the American Psychological Association, voices the opinion of many a psychologist today when he says in concluding: "My plea, therefore, is . . . . . that we keep psychology from becoming a cult from which original and daring inquiry is ruled out by the application of one-sided tests of method; that we come to evaluate our science rather by its success in enhancing—above the levels achieved by common sense—our powers of predicting, understanding, and controlling human action."[2]

Attempts to deal with the real problems of human existence are not new in psychology. But, except in very limited areas, the attempt to present to the student or to the adult layman what psychologists do know about these problems is relatively new. To be sure, our knowledge is still limited. Theories and opinions loom larger than facts, but the evidence is such that many of these theories are at least *probably* true. In fact, when one sets out to present the practical implications of psychological findings, even the most cautious and careful conclusions add up to a rather impressive total.

The problem is basically one of selection of the material for inclusion in such a presentation. Until recently, for example, teachers of psychology assumed that every student who took an elementary course must be given the same fundamental training as the student who was going on to take a Ph.D. in the field. This was one of the major reasons for the inclusion of so much physiology, for example, in the elementary psychological textbooks of a few years ago. Today we are beginning to recognize that, for the student who hopes to obtain some knowledge of ultimate practical value from a *single* course in psychology, this physiological material can be almost completely eliminated.

But if we are to exclude what was actually the major portion of the content of the traditional elementary psychology, do we have anything but hot air with which to replace it? A series of books which have appeared within the last few years, and which are being published currently in increasing volume, will enable the curious to decide for themselves. It is the purpose of this review to discuss briefly two of these books in order to encourage the reader to examine them for himself.

One of the first psychologists to break completely with tradition in the writing of an elementary psychology was Floyd L. Ruch. His "Psychology and Life," published in 1937, was written to meet the expressed needs and interests of students, college administrators, and men and women who had studied psychology ten years before. This book has been widely acclaimed. Like any enthusiastic exponent of a new cause, however, Ruch is open to the charge that he has gone from one extreme to the other. In attempting to write a psychology which would be useful and readable, he has perhaps too frequently ignored qualifications of considerable importance when drawing conclusions and stating principles. In the light of the momentum of the trend which he initiated, only a carping critic would dwell upon this criticism. Ruch gave others the opportunity to learn from his mistakes, and to him should go full credit for providing the real impetus for a movement which was long overdue.

Two examples of this current approach to the study of psychology have been selected for discussion in this review. The first[3] has been definitely written for the adult layman, while the second[4] is one of the best of the recent textbooks in psychology.

"We Call It Human Nature" was written by a layman in

[1] One of a series of reviews of current economic literature affecting engineering prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

[2] *Psychological Bulletin*, vol. 37, 1940, p. 26.

[3] "We Call It Human Nature," by Paul Grabbe, Harpers, New York, 1939.

[4] "The Psychology of Normal People," by Joseph Tiffin, Frederic B. Knight, and Charles C. Josey, Heath, Boston, 1940.

close corroboration with an outstanding American psychologist (Gardner Murphy, formerly of Columbia University, now chairman of the department of psychology at College of the City of New York). The emphasis throughout is based upon those aspects of psychology which are likely to be of interest to the nonacademic adult. But this is only one of the unusual features of this remarkable little book. Grabbe has a keen appreciation of the value of graphic and pictorial methods. As a result the text occupies less than half of the 120 pages. The balance is reminiscent of the magazine *Life*. Ingenious and easily grasped diagrams and charts, and a truly magnificent selection of photographs combine to give the reader a birds-eye view of psychology which he cannot help but find fascinating. Moreover, even the specialist in the field can find little in the way of overgeneralization or misleading statement of fact. Says Professor Murphy in his foreword, "We have worked to make this book authentic, factual, accurate. Hundreds of sentences have been rewritten over and over again because of slight shadings that might conceivably lead to some misunderstanding. We have indeed not limited ourselves to those experimental facts which every laboratory has verified, but we have constantly tried to make clear the difference between an established fact and a reasonable guess. . . . . The reader who hungers for further factual information and the sources from which it is derived will find many references indicated to which he may turn." The writers recognize that one need not present the whole theory of a subject in order to draw for the reader a specific conclusion. Adequate documentation provides the critical reader with the means to dig into the evidence if he chooses.

This book is enthusiastically recommended to the man who, although he has never studied psychology, is either suspicious of its value or curious about its content. It might also be an eye-opener to the man who feels that the elementary course in psychology which he took some years ago in college was pretty much a waste of time and energy.

"The Psychology of Normal People" is somewhat more conventional in form and considerably more detailed in its treatment of psychology than the book just discussed. Its authors say of it in their preface: "This book is written for students who expect their four years at college to prepare them for acceptable service in business, industry, and the professions. The content has been determined not only by what fellow psychologists believe should compose a first course in psychology, but also by what alumni now meeting the problems of business and industry wish they had studied while they were in college." The authors have taken advantage of "deliberate counsel with superintendents of steel mills. . . . .; with personnel managers of large department stores . . . . .; with resident physicians in large hospitals . . . . .; and with superintendents of schools. . . . . It is hoped that this union of counsel between fellow psychologists who prepare, and men of business who use, the product of our colleges and universities has created a text which will be useful as well as scientifically sound." It is the opinion of this reviewer that the authors have achieved their purpose admirably.

In their selection of material for inclusion in this book, they have carefully avoided detailed discussions of theories and of experimental techniques which could be useful only to the potential specialist. For example, a detailed knowledge of the techniques of psychological testing is highly important for the professional psychologist, and perhaps for the personnel executive. But a slight acquaintance with the how and why of testing will enable the industrial executive to make an intelligent decision concerning the usefulness of tests as tools for employment selection in his plant. This acquaintance will also enable him to realize that expert guidance is necessary in the development and use of tests in any practical situation, and it will make him considerably less gullible concerning the claims of the many psychological quacks who flourish in this area. The person who has read this book carefully will have a healthy skepticism concerning his own ability to judge personality and ability at sight, and he will also be aware of the limitations as well as the positive advantages of more scientific methods of selection. Yet he will not have been required to wade through whole chapters filled with an elaborate critique of specialized statistical methods, and with a terminology which could not conceivably be useful outside of the psychological laboratory.

Of some 500 pages, approximately six are concerned with the physiology of the nervous system, and the reasons for the inclusion of those six pages will be perfectly apparent to the reader. Throughout the book the attempt is made to give the student a fair understanding of the why and how of normal everyday behavior in so far as the psychologist can draw intelligent conclusions about these matters from the evidence at his command. The student will not be a psychologist when he has finished studying it, but he will be equipped with a new perspective concerning human behavior, and frequently during the years ahead he will find this perspective influencing his own behavior and his decisions concerning the behavior of others. An occasional reader will find himself eagerly following up some particular area of psychology by way of the excellent references furnished by the authors.

The adult need not shy away from this book because it was written for college students. He will almost never feel that the authors are "writing down" to him. The arrangement of the material, and the manner of presentation is such that he will remember he is reading a text only when he reaches the list of "questions for discussion" at the end of the chapters. If he is interested in following up in more detail the brief survey of psychology presented by Grabbe, or if he would like to see for himself how psychology has developed in recent years, here is a book which will probably surprise him by its power to hold his attention and interest. Psychology, as it is being presented today, *is* "good for something." If the reader doubts the truth of this statement, let him read either of these books. This reviewer will try not to say "I told you so" too loudly afterward.

Attic Cooling Systems

DURING the summer the sun beats down on the roof and raises the temperature of many an attic to 130 F or more. This heat is absorbed by the house and makes living and sleeping quarters extremely uncomfortable. At night this accumulated heat is dissipated so slowly that it is usually early morning before it is really cool enough for comfortable sleeping. However, it is possible to prevent heat from accumulating in the attic during the day and to cool the house at night by making use of a ventilating fan. Changing the air many times an hour, this fan will drive out the warm air and bring in the night air which is 15 to 20 degrees cooler than the daytime air.

The ventilating-fan system can be adapted to the needs of almost every type of home. A propeller-type exhaust fan is located in the attic over an open grille placed in the ceiling of the top floor. Louvered openings or windows are provided in the attic with sufficient outlet area to permit an easy egress for the air which is drawn up from the rooms below, into which in turn the cool air is drawn through open windows and doors. Home cooling by attic ventilation is not to be considered as a substitute for complete air conditioning, but it is a practical and inexpensive means of securing relief from summer heat.—Abstract from "The Installation and Use of Attic Fans," by W. H. Badgett, Bulletin No. 52, A.&M. College of Texas, College Station, Texas.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Day by Day

WAR in Europe interrupted the exchange of courtesies between engineering societies in Great Britain and this country that had centered around the award of honors to distinguished members. Within the last few months, however, honorary membership in the A.S.M.E. was bestowed on E. Bruce Ball in London, the A.S.M.E. Medal was delivered to Sir Stephen J. Pigott in Glasgow, and the James Watt Medal, of The Institution of Mechanical Engineers, was presented to Henry Ford at Detroit.

E. Bruce Ball

One year ago preparations for the British American Engineering Congress were at their height. They included the conferring of honorary membership in The American Society of Mechanical Engineers on E. Bruce Ball, at that time president of The Institution of Mechanical Engineers, of Great Britain. Outbreak of war in September necessitated cancellation of the Congress and of the ceremony at which Mr. Ball was to have been honored. On April 25, 1940, at Grosvenor House, the postponed ceremony was observed in the presence of the councils of The Institution of Mechanical Engineers and the Institution of Civil Engineers, who had as their guest at luncheon His Excellency the United States Ambassador, Joseph P. Kennedy. On behalf of The American Society of Mechanical Engineers Mr. Kennedy presented the certificate of honorary membership to E. Bruce Ball, and on behalf of the American Society of Civil Engineers he conferred a similar honor on W. J. E. Binnie, president of the Institution of Civil Engineers in 1939. (An interesting side light of the ceremony was the reported announcement by Sir Clement Hindley, president I.C.E., that the occasion was the first at which the councils of the two institutions had taken luncheon together.)

Mr. Ball, who is managing director of the firm of Glenfield and Kennedy, Ltd., of Kilmarnock, Scotland, was born at Thetford, Norfolk, in 1873. His education and training were of that thorough British character that places so much emphasis on works apprenticeship at an early age, and is rounded out by active engineering experience in divers firms in many parts of the world. Mr. Ball's four-and-one-half-year apprenticeship was served at the works of Charles Burrell and Sons, Ltd., Thetford, during which time he attended technical classes. At the age of 20 he gained the first science scholarship offered by the Norfolk County Council and became Queens prizeman for that year. These two years were spent at the Manchester school where he obtained a Whitworth Exhibition and a School of Mines scholarship. The latter he did not take up but returned to industry.

After a period as draftsman he became chief designer to Benjamin Goodfellow & Co., of Hyde near Manchester, on mill engines, refrigerators, and winding engines. Subsequently he was appointed works manager to Reavell & Co. Ltd., Ipswich, where he had a large experience in the construction of high-speed engines and air compressors. After being five years with this firm he accepted the management of the steam-car works of Clarkson Ltd., Chelmsford, and later he spent three years in Italy as the technical director of the San Giorgi Company. During this period he constructed the company's new plant for marine internal-combustion engines and automobiles under the Napier patents, and an important amalgamation of Italian interests was effected with the Laurenti submarine works at Spezzia. On the completion of this engagement Mr. Ball went to the Far East as engineer and later director to the firm of Samuel & Co. Ltd., of Shanghai. He represented many important British firms in China, Manchuria, and Siberia for waterworks, mining, and railway plant. On his return to England he received the appointment of general works manager to D. Napier & Sons Ltd., London, where for over five years he developed the manufacturing side of the business. During the Great War he organized plants for the construction of airplanes and aircraft engines, including the development of the Napier Lion.

With the consent of the Ministry of Munitions Mr. Ball accepted his present position of managing director to Glenfield and Kennedy, Ltd., hydraulic engineers, Kilmarnock, and took up his duties on July 1, 1918. In addition to manufacturing water-supply apparatus and recording instruments, the construction of hydraulic equipment for docks, steel works, hydro-electric plants, and sluice gates for barrages and dams, forms a major part of the heavy engineering side of the business.

In 1920 on behalf of the company he acquired the foreign rights of the American Pitometer Co., and formed as a subsidiary, the British Pitometer Co. Ltd., London, of which he is a director; also in 1930 took over the business of Hydrautomat (1931) Ltd., London, of which he is chairman. The manufacturing side of both these subsidiary companies is undertaken by the parent company at Kilmarnock.

He had been vice-president of the London District of Engineering Employers, and chairman of the Aircraft Manufacturers Committee of that body during the Great War, and in 1939 was president of The Institution of Mechanical Engineers. He served as vice-president of the British Engineers Association; was a member of the Engineering Divisional Council British Standards Institution; member of Council and Executive Committee, Federation of British Industries; and president of the South Ayrshire District Association of Engineering Employers.

Mr. Ball will be remembered as author of a paper "Methods Employed to Remedy Water-Hammer Shock in Pumping Stations," presented at the 1937 A.S.M.E. Annual Meeting and published in Transactions, January, 1939, and for other engineering papers relating to hydraulics and irrigation. The firm of Glenfield and Kennedy, Ltd., which Mr. Ball serves as managing director, was formed in 1899 by the amalgamation of two parent companies, The Kennedy Patent Water Meter Company, itself the outcome of a Meter Syndicate formed in 1852, and The Glenfield Company. Mr. Ball recently sent to this country a history of his company, an illustrated book of 142 pages entitled "A Romance of Industrial Engineering," by James P. Morris, Glenfield and Company, Ltd., who has been a

director of one or another of the constituent companies for more than 50 years.

Pigott Honored

On June 3, 1940, at Glasgow, Scotland, Sir Stephen J. Pigott, managing director, John Brown & Co., Ltd., Clydebank, builders of the *Queen Mary* and *Queen Elizabeth*, received the A.S.M.E. Medal and certificate "for outstanding leadership in marine propulsion and construction," from the hands of the United States Consul-General, Leslie A. Davis, to whom they had been forwarded. The ceremony took place at Mr. Davis' home in the presence of a few distinguished guests from Glasgow and Clydeside.

Sir Stephen was born in the United States, was educated at Columbia University, and cooperated with Charles G. Curtis in the development of the impulse steam turbine for ship propulsion. Early in 1908, at the invitation of the British Admiralty, he went to Scotland where he became associated with impulse-turbine development at Clydebank. He was appointed local director, John Brown & Co., Ltd., in 1920, was elected a full director in 1934, and has held the position of director-in-charge at the Clydebank works since March, 1935. As local director of the company's engine works, he was responsible for the propelling machinery of the *Queen Mary*, and as director-in-charge at Clydebank he had full responsibility for the construction of the *Queen Elizabeth*. Sir Stephen was knighted by His Majesty King George VI on February 16, 1939.

Oliver Evans Memorial

Under the auspices of the trustees of The American Scenic and Historic Preservation Society a granite shaft bearing a tribute in bronze to Oliver Evans was dedicated on June 12, 1940, at Trinity Cemetery, New York, N. Y. Dr. Charles E. Lucke, of Columbia University, represented The American Society of Mechanical Engineers as an honorary vice-president and delivered one of the addresses. Other speakers were Julian Boyd, librarian of Princeton University, Greville Bathe, of Philadelphia, biographer of Oliver Evans and donor of the monument, and George A. Zabriske, president, The New York Historical Society. Le Roy E. Kimball, president, The American Scenic and Historic Preservation Society presided. The invocation was pronounced by the Rector of the Church of St. Matthew and St. Timothy, the Reverend Frederick Burgess, who also offered the dedicatory prayer.

The bronze tablet contains the following inscription:

TO THE MEMORY OF
OLIVER EVANS
Born in Delaware, September 13, 1755
Died in New York, April 15, 1819
ENGINEER

Whose pioneer work in the application of high pressure steam to locomotion and industry with the introduction of automatic machinery in flour milling; whose creative writings on technical and scientific subjects, and enterprise as a manufacturer and promoter of useful inventions place him in the front rank of those who laid the foundations of America's greatness as an industrial and scientific nation this tablet is erected in appreciation

by

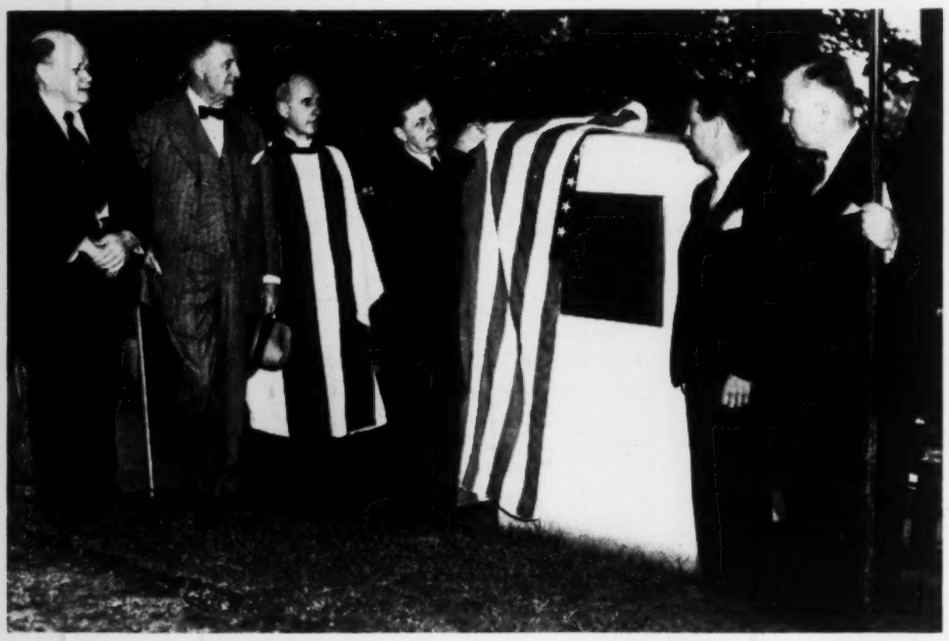
Greville Bathe and sponsored by
The American Scenic and Historic Preservation Society

Dr. Lucke's address dealt with the engineering background of the times in which Oliver Evans lived and with the inventor's contributions to the early development of steam power in this country for stationary use and for transportation on land and water. He said in part:

Evans proposed the use of steam pressures substantially higher than that of the atmosphere, which would permit of operation without the condenser that requires a supply of cooling water, the cylinders exhausting directly into the atmosphere, but, of course, a condenser could be added if, and when, conditions were favorable. He recognized that this use of high-pressure steam with atmospheric exhaust made the steam engine adapted to the driving of a wagon, a steam wagon, where cooling water is not available, and that it would increase the horsepower of any engine with or without a condenser, the latter being suitable for boats, and thus decrease the cost per horsepower compared to the use of low-pressure steam. He also recognized that high steam pressure would increase the ratio of expansion to the exhaust pressure, and that this would decrease the fuel consumption by increasing the efficiency in the use of the steam.

However, operation with the desired high steam pressure required a special sort of steam boiler adapted to resist bursting, and that to get a high efficiency in the generation of steam, the boiler must also have some other special features to promote heat absorption from the furnace and its hot gases. Evans devised such a boiler.

Engineers regard Oliver Evans as a great man of their own kind, belonging to a past generation, whose works they have inherited and utilized, but there should be corresponding acknowledgment of



UNVEILING OF MONUMENT TO OLIVER EVANS
(Left to right: Dr. Charles E. Lucke, George A. Zabriskie, the Reverend Frederick Burgess, Greville Bathe, Julian Boyd, and Le Roy E. Kimball.)

his contribution to the economic building of America, as having laid some of the foundations of American industry, which is so much of the strength of America. This country needs more Oliver Evans'. We must seek out the potential Oliver Evans' of the future, see to it that they are fostered, remove any obstacle that might limit the free play of their creative ability, and promote individual enterprise in the public interest.

Ford and Watt

As noted in the issue of October, 1939, the 1939 James Watt International Medal of The Institution of Mechanical Engineers was awarded to Henry Ford, member of the A.S.M.E. When Mr. Ford was forced to abandon his plan to receive the medal in person in London, the medal was forwarded to The American Society of Mechanical Engineers and was finally presented to Mr. Ford by Alex Dow, past-president and honorary member, A.S.M.E., at a dinner held in Detroit on June 25. Present at the dinner were several present and past officers of the Detroit Section of the Society, Secretary C. E. Davies, and Mortimer E. Cooley, past-president and honorary member.

The medal was established by the Council of The Institution of Mechanical Engineers in 1936 at the time of the Bicentenary of the birth of James Watt, and is awarded biennially with the cooperation of the mechanical-engineering societies in leading industrial countries. Sir James Aspinall, honorary member A.S.M.E., recently deceased, was the first recipient of the medal.

HENRY FORD TAKES A LOOK AT THE JAMES WATT MEDAL

(The medal, held by Secretary Davies, was awarded to Mr. Ford in 1939 by The Institution of Mechanical Engineers and presented at a dinner, Detroit, Mich., June 25, by Alex Dow (left). M. E. Cooley stands at Mr. Ford's left.)

New Heat-Transfer Liquid

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

A NEW chemical mixture used as a heating and cooling liquid which will transfer heat up to 900 F was described in a paper presented at a meeting of the American Institute of Chemical Engineers at Buffalo, N. Y., May 14. The paper, entitled "A New Heat-Transfer Medium for High Temperatures," was given by Dr. W. M. Nagle, W. E. Kirst, and J. B. Castner, all of E. I. du Pont de Nemours & Co. Consisting of approximately 40 per cent sodium nitrite, 7 per cent sodium nitrate, and 53 per cent potassium nitrate, the mixture has a low melting point, high heat-transfer rate, and a thermal stability and a lack of corrosive action on steel at temperatures above those obtained with Dowtherm, hot oil, or high steam pressure. Obtainable in salt form, the solid material may be melted with 150 lb steam pressure at 288 F, and when molten can be pumped like water.

More than 1,000,000 lb of the salt mixture have been used at 800 F in single units of oil-refinery plants and the economical use of this mixture at such high temperatures demonstrates its potentialities for heating and other uses. Suitable equipment for use of the material in small kilns and stills is now being developed. Besides oil refineries and chemical plants, the salt is being considered for utilization in bakeries, starch plants, clay regeneration units, and asphalt stills. According to Dr. Nagle, it requires 48 air pipes to transfer the same amount of heat as one pipe handling the molten salt will transmit. Theoretically it would also require 1700 times as much power to force the air through these pipes as would be required to pump the salt solution.

Optical Plastic

1940 WORCESTER MEETING, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

DURING an inspection trip to the Norton Company by members attending the 1940 Spring Meeting of The American Society of Mechanical Engineers in Worcester, Mass., the company's research engineers showed them a new type of plastic material which can be used for optical purposes. This nonmoldable resin can be readily sawed, drilled, turned, and even ground and polished on opticians' laps. It does not exhibit true plastic flow under heat and pressure but may be bent to shape at 160 C. The tensile strength of the material at room temperature is 8000 to 10,000 psi, and the hardness is 60–62 on a Rockwell C scale with a 68-kg load and $^1/_8$-in. ball for 15 sec. Its stability to sunlight and ultraviolet light is excellent. Nonbreakable eyeglasses are now being produced from this material by an optical company on an experimental basis.

New High-Temperature Alloy

POWER PLANT ENGINEERING

ACCORDING to a note in the May, 1940, *Power Plant Engineering*, P. H. Brace of the Westinghouse Research Laboratories has produced a new alloy, containing only seven per cent

iron, which is stronger than any known steel. It retains its strength at temperatures higher than 2000 F. The alloy, which is the result of almost seven years of research work, is actually stronger at 1100 F than ordinary low-carbon steel is at room temperature. Stranger still, it has a low damping coefficient, or in other words, it retains its elasticity at such elevated temperatures.

Almost half of K-42-B, as it is known, is nickel, and about a quarter is cobalt. Other components include chromium, titanium, and iron. Production of the metal on a commercial scale is known to be practical, but its first cost will be high, and its immediate uses are expected to be those of a special-purpose alloy for dies, valves, steam fittings, and, possibly, turbine blades and other applications requiring temperature-resistant metals. It is reported that the new alloy "creeps" a great deal less than other metals in its class.

New U. S. Navy Airplane

THE FOUNDATION

A NEW Navy fighting airplane has just been turned over for testing to the trials board of the Navy Department by the Grumman Aircraft Manufacturing Company, states an article in the May, 1940, issue of *The Foundation*, official publication of The Engineering Society of Detroit. The Grumman *Skyrocket*, or officially the XF5F-1, is a twin-engine, all-metal, single-seat fighter with, of course, retractable landing gear. It is powered by two Wright air-cooled engines of 1200 hp each, at take-off. As shown in Fig. 1, the airplane is a monoplane of most unusual appearance with square wing tips and tail which are provided for ease and rapidity of production but which do not detract from its phenomenal performance.

The armament consists of guns mounted in the nose and firing between the propellers which eliminates any hazard from shooting through each propeller, and also increases the rate of fire. The number and caliber of guns have been increased over previous Navy airplanes. One very unusual feature of this airplane is the fact that, differing from almost all other multiple-engine aircraft, the Curtiss 10-ft-diameter, electric-feathering, three-blade propellers rotate in opposite directions.

Weighing only 9000 lb and with a wing span of 40 ft, the *Skyrocket* is capable of speeds well in excess of the top speeds of any fighting airplane either here or abroad. Furthermore, it can outclimb any airplane yet built because of its high horsepower per pound of airplane. The air-cooled engines are less vulnerable to gun fire as shown by recent experiences on the battle areas of Europe when engines of this type continued running after being pierced in numerous places by bullets.

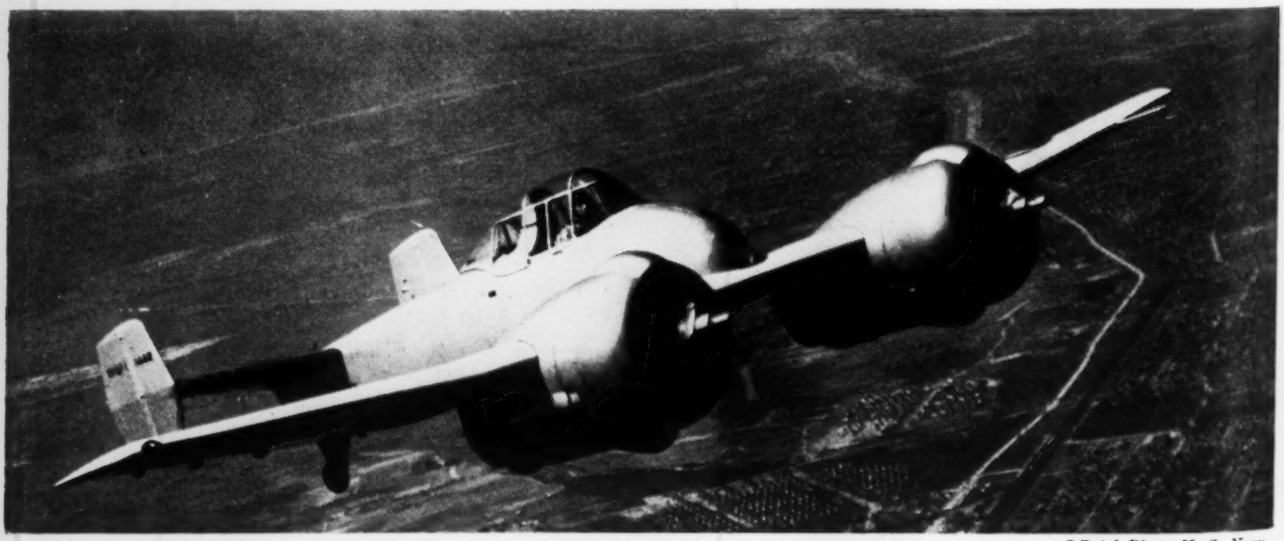
Built-In Airplane Engines

VARIOUS SOURCES

NEWSPAPERS recently carried reports about a new American military airplane, the Bell P 39 *Airacobra*, in which the engine, a liquid-cooled Allison with an exhaust-driven supercharger, is mounted behind the pilot and drives the propeller through an extension shaft. This idea of a "submerged," or built-in, engine in the fuselage or in a wing has been utilized by the British in the Westland F 7-30, and by the Germans in the Junkers G 38, Dornier Do 18, and Dornier Do 26. According to W. E. Beall and E. G. Emery, Jr., Boeing Aircraft Co., in a paper read before the Society of Automotive Engineers in October, 1939, the advantages of a built-in engine installation are almost entirely gains in aerodynamic performance. These gains include increased propulsive efficiency due to the lack of propeller interference with the nacelles; increased lift because the smaller extension shafts do not blanket or prematurely stall the wing as is the case with the larger nacelles; the reduction of drag due to the elimination of the larger nacelles; and the elimination of wing-nacelle interference.

Main problems of this type of installation, claim the authors, are as follows: (1) The design of a satisfactory propeller shaft; (2) the satisfactory and safe disposal of the exhaust gases; (3) the over-all cooling of the engine compartment, cylinder cooling, supercharged air cooling, lubricating oil cooling, accessory cooling, and exhaust disposal system cooling; and (4) the mounting of the engine.

The successful operation by the Germans of airplanes utilizing this feature has proved that the problems can be solved, especially the one concerning propeller-shaft extensions. As described in a recent issue of the *Junkers Nachrichten*, the first propeller-shaft extensions fitted in airplanes were of the angle type as required for use in airplanes having the power plant centrally located in the fuselage, with the engine, or engines,



Official Photo U. S. Navy

FIG. 1 GRUMMAN TWIN-ENGINE FIGHTING AIRPLANE BUILT FOR U. S. NAVY

driving one or more propellers which were not in line with the crankshaft. Such arrangements were employed as early as before World War I in the first Zeppelins and later, during the war, in the giant airplanes of that time. They were known as "outrigger gears." After the war, the Junkers Co. used a similar scheme experimentally on a Ju-33 airplane in which the engine was placed in the fuselage, driving two propellers arranged over the wings. However, this type of installation was not satisfactory because, besides causing an increase in weight, it reduced mechanical efficiency by two or three per cent.

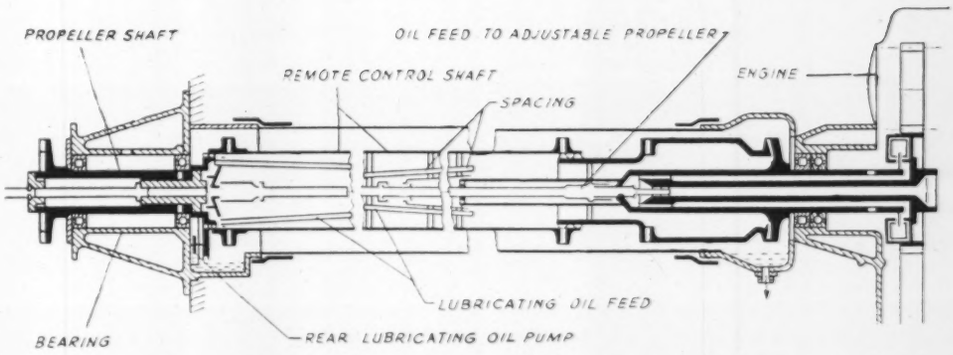


FIG. 2 DIAGRAM OF JUNKERS EXTENSION SHAFT USED WITH A JUMO-205 DIESEL ENGINE TO DRIVE A PUSHER PROPELLER ON THE DORNIER DO 18 FLYING BOAT

For the time being, therefore, and in the near future, straight-line propeller-shaft extensions appear to offer the brightest prospects. Such shaft extensions have been developed during the last ten years and have proved successful in German transport planes. The Junkers shaft (Fig. 2) has internal vibration dampers. It is nearly 6.5 ft long and weighs 161 lb, including the propeller bearing, and is used to transmit the torque from a Jumo-205 Diesel engine to a pusher propeller. Each additional foot of length between the propeller and engine entails an extra weight of only 11.5 lb. The shaft extension does not require attention or servicing in flight, so that no extra burden is placed on the crew.

The provision of propeller shaft extensions in the Junkers G-38 airplane has made it possible to place the engine inside the wings, thus affording perfectly smooth upper and lower surfaces with no drag-increasing unevenness. Passages in the wings of sufficient height for a man to walk erect makes the engines accessible for inspection in flight. This arrangement also enables the propellers to be fitted at some distance forward of the leading edge of the wings.

The straight-line propeller-shaft extension also enables the torques of a number of engines to be combined in a common gearbox and passed to a single propeller. Of course, such arrangements require the fitting of clutches which can be actuated at will while the power plant is in operation, since provision must be made for starting, warming up, and stopping (in case of trouble) each engine separately with the propeller at a standstill. A free-wheeling device is also necessary for each engine, so that a defective one may be disengaged from the rest without affecting the proper performance of the power unit.

Projection Welding

THE WELDING JOURNAL

PROJECTION welding is defined by L. H. Frost, in an article appearing in the March, 1940, issue of *The Welding Journal*, as a process of resistance welding by which a weld is obtained at the desired location by means of an embossment on the part being welded. This means that this method of welding is inherently a production method, since the increased speed of welding is obtained with multiple projections which make possible all these welds with a single operation of the machine. The method differs from spot welding in that the embossment, rather than the size of the electrode tip, determines the size and location of the weld.

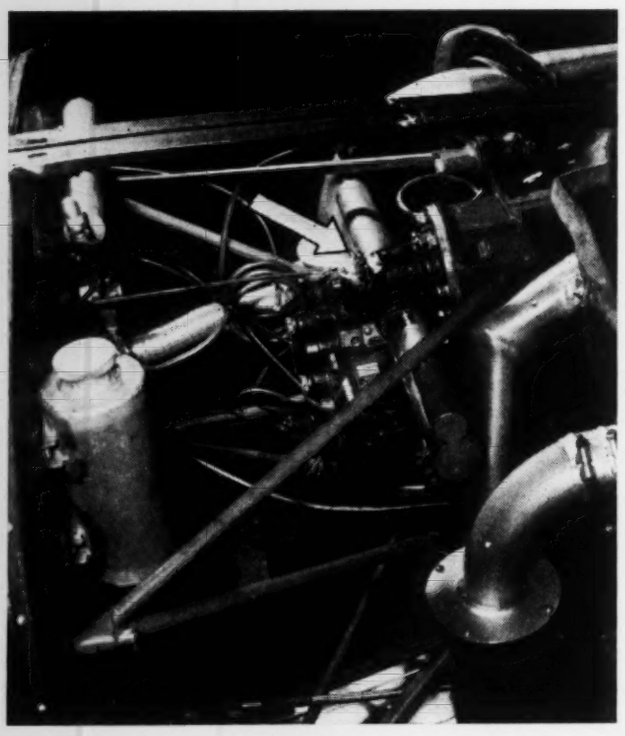
The type of machine used for this work has all the characteristics of a heavy-duty production machine, and the setup is more like other production machines, such as punch presses and screw machines, states Mr. Frost. In projection welding, the type of projection is called the button type, and is rounded where it contacts the other piece to be welded. Above 12 gage, these embossments are commonly cone-shaped, because of punches and dies required for the forming operation. The principal factors to consider are the necessity of maintaining the proper height, as well as equal distribution of current and pressure. A form of this type of welding joins studs to plates. Any metal which can be satisfactorily spot-welded, or welded by the resistance process, can be successfully welded by projection welding. Several metals, such as some copper alloys, which cannot be welded by the spot-welding method can be welded by this method.

Schools and Industrial Research

INDUSTRIAL RESEARCH INSTITUTE

FAILURE of universities to attach sufficient importance to the "time element" has frequently prevented greatest possible cooperation between the universities and industry in research activities, declared L. W. Wallace, past vice-president A.S.M.E., in speaking for industry at a panel discussion on relations between industry and universities, during the annual meeting of the Industrial Research Institute, Cincinnati, Ohio, April 26–27, 1940. He declared that while industry often looked to universities having special equipment and experts in particular scientific fields for some of their research development, the universities' disregard of the importance of time often stood in the way of maximum cooperative endeavor.

He said many graduates today have neither the exploring urge nor the inquiring mind, adding that few seem to appreciate the value of and adequately make use of the processes of analysis and synthesis which are so fundamental to successful endeavor. Because of this there is not sufficient coordination and correlation in what they do. What is needed are men who can and do think broadly, deeply, and honestly. Industry would rather have men with these mental attributes than those most skillful in the use of slide rules and chemical balances. Universities are not giving enough time to the intellectual and mental phases involved in industrial research. There should be more problems requiring imagination and definite thinking to solve and fewer laboratory operations. In this day of technology, the findings in fields supposedly remote to one's own interest may be exceedingly valuable because of the adaptations which may be made.



NEW 15-LB HYDRAULIC SELF-STARTER FOR LIGHT AIRPLANES

(An article in a recent issue of *The New York Times* described an airplane self-starter developed by Wayne Criley, a 29-year-old aeronautical engineer. Shown here installed in a Stinson 105 airplane, the starter, in three sections, generates hydraulic power up to 700 psi in the pressure chamber. To start an engine with it, the pilot spins a small crank in the plane's cockpit. This forces fluid into an injector, then into a hydraulic cell where the pressure has been preloaded to from 150 to 190 psi. The force built up from the outside raises the pressure to a maximum of between 600 and 700 psi. This potential energy remains in the cell until the pilot, releasing a trip button on the instrument panel, allows the power he has created to act upon the starting mechanism.)

Dean Charles E. MacQuigg, The Ohio State University, speaking for the universities, declared that modern life is binding the individual constantly closer to industry and that industry should now have a part in formulating the education of modern youth. He said that manufacturers, capitalists, and others connected with industry can now safely and logically cooperate with the schools and colleges in guiding educational trends.

Qualifying Mr. Wallace' viewpoints, Alex D. Bailey, past vice-president A.S.M.E., also speaking for industry, said that it is hard to conceive of situations where private industry is justified in promoting fundamental research at universities for donation to the public. No doubt, research has considerable advertising value, but in such case this would accrue mostly to the university and not to the financial sponsor. Moreover, it frequently happens that the public's interests are best protected against unscrupulous promotion or the lack of any development when the rights are not donated to the public at large but control retained by some beneficent agency.

Dealing with the important question of patent rights on research findings developed in university laboratories, Dean Edward L. Moreland, of M.I.T., member A.S.M.E., declared that educational institutions do not want to compete with commercial companies and are therefore adverse to granting "exclusive" patent rights to industry on cooperative projects. Fellowship grants are acceptable from industry for research work in a "field" and not on a specific project. He strongly reiterated that industry's representatives are welcomed at the universities as "observers" of research work undertaken in behalf of industry but not as "supervisors."

Engineering Registration Today

CIVIL ENGINEERING

A REVIEW of the problems faced and the progress made to date in the legal registration of professional engineers is given by T. Keith Legaré, executive secretary, National Council of State Boards of Engineering Examiners, in an article appearing in *Civil Engineering* for May, 1940. As shown in Fig. 3, Wyoming adopted the first state law regulating the practice of professional engineering in 1907, and was followed by Louisiana in 1908, then by Illinois in 1915, and by Florida in 1917. However, it was not until the period from 1919 to 1922, when 17 states joined the registration group, that the registration of engineers became a nation-wide movement.

There now remain only six states—Delaware, Massachusetts, Missouri, Montana, New Hampshire, and North Dakota—which do not have laws requiring the registration of engineers, and three of these have active committees that are preparing such legislation. The District of Columbia has a registration bill pending in Congress, and Alaska has appointed a committee to investigate the desirability of a registration law. Several states are now considering amendments to existing laws in order to include additional classifications or to improve the provisions for administration and general procedure. The trend of engineering registration in recent years seems to indicate that in a few more years every state in the Union will require the legal registration of all professional engineers who are in responsible charge of engineering work wherein the public welfare and the safeguarding of life, health, or property are concerned.

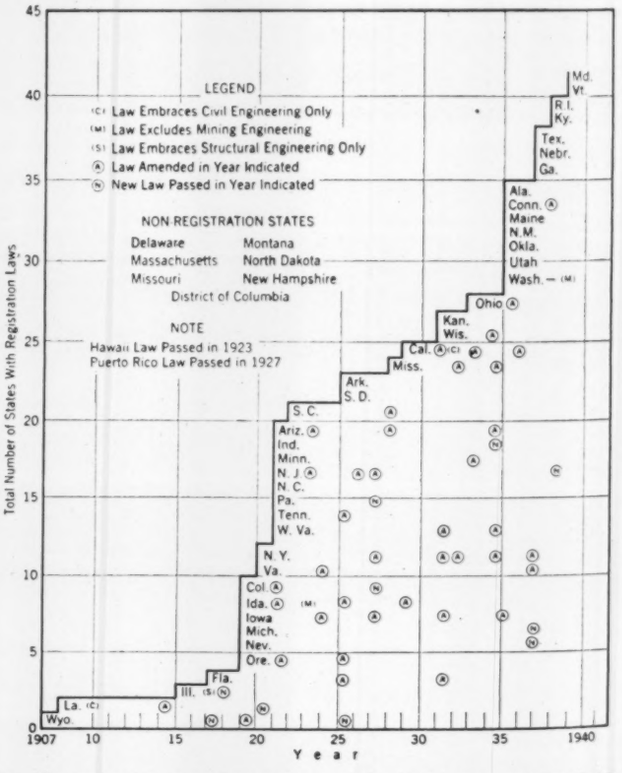


FIG. 3 PROGRESS OF LEGISLATION GOVERNING THE PRACTICE OF PROFESSIONAL ENGINEERING

Plastics Versus Metals

METALS AND ALLOYS

THE substitution of plastics for metals, except in a limited number of isolated instances, is highly improbable, states Herbert Chase in an article appearing in the June, 1940, *Metals and Alloys*. All references in the article apply to the synthetic types of plastics and, therefore, exclude rubber, the most important of all plastics.

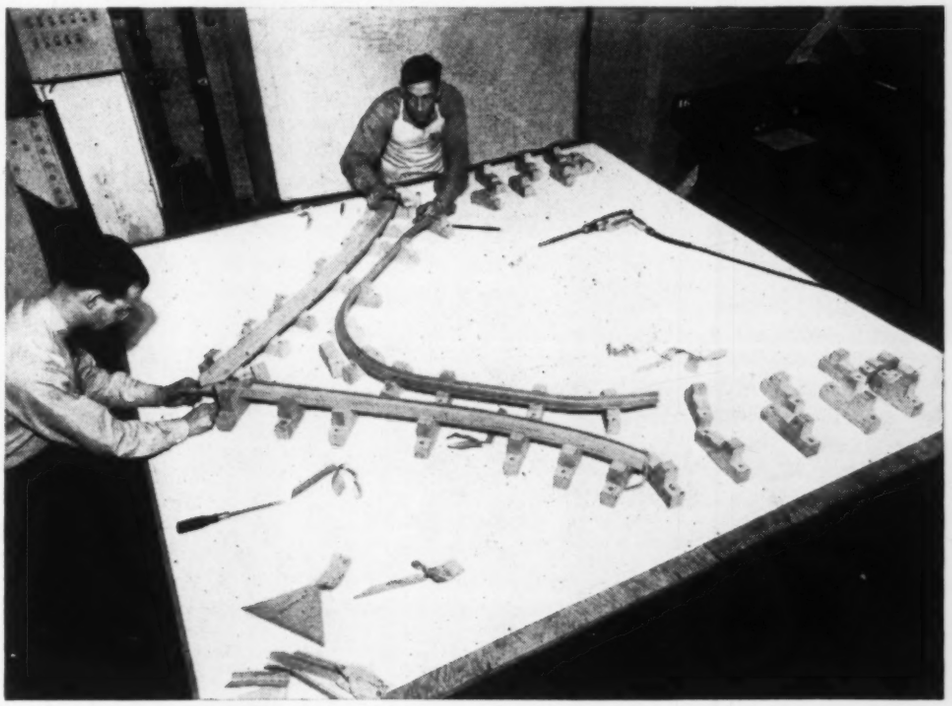
The first synthetic plastic (pyroxylin type), now some 75 years old and still in wide use, remains among the more expensive types. Much less expensive and in widest use is the phenolic type, introduced over 30 years ago. This is the cheapest form in wide use, yet it sells in large quantities for about 12 cents per lb, minimum, for the general-purpose grade. Most other forms, including those which are transparent and translucent and which come in the many beautiful colors, about which much is said, range in price from about 30 cents to $1 or more per lb. It is true that plastics are much lighter than metals, but even on a strength-weight basis they nearly all cost considerably more than the commoner metal and frequently more than metals and alloys of intermediate price. This is not always true in the fabricated forms of both types of material, but it usually is when the plastic part is made as strong as that in metal. Clearly, if plastics are to displace metal in a large way, costs must be competitive and, to date, the evidence that they will be is, at best, far from being convincing.

When the strength of plastics and of metals is compared, plastics are almost always greatly inferior. Nearly all plastics, and especially those suitable for molding, must be classed as relatively brittle. The ductility and toughness which characterize steel and most wrought metals are never approached in plastics. Even the common cast metals, some of which are relatively brittle as compared with wrought metals, are much less so than plastics. However, there is somewhat less disparity as between metals and plastics in comparisons of tensile, compressive, and bending strength but, in general, the difference is still pronounced. It is possible, of course, to reinforce plastics with paper, metals, or fabric, as in laminated sheets, thus increasing their strength by reason of the reinforcement, but when this is done with sheet materials, the plastic is no longer readily moldable or at best cannot be molded in any but simple and shallow forms. Even then, strength is far short of that attained with most metals.

Lest some raise the question, "What about plastic instrument panels, already used in passenger cars?" it may be well to answer that no American Car has such a panel. The panel itself is sheet steel. A few have plastic parts as large as glove-compartment doors, but some of these are molded over steel and those which are not so reinforced are thick and expensive and still fit into or over a metal panel. Most cars, including some on which plastics have been tried and dropped for large parts, now have die-cast zinc-alloy radio grilles, instrument frames, or glove doors, or use equivalent parts in pressed steel.

Another consideration is the time required and cost involved in molding, especially of large plastic parts, as compared, for example, with the rapid stamping of steel or the die-casting of zinc and of aluminum alloys. It is true, of course, that plastics commonly require no applied finish and consequently they save, as a rule, the cost of finishing. This is sometimes an important advantage, but it applies only where the desired color is obtained in the molding itself, and it must not be forgotten that the cheaper forms of plastics come chiefly in black, brown, and dark colors, some of which are not light-fast. If one wants light and stable colors, it is necessary either to go to the more expensive plastics or to apply a finish over the dark and inexpensive plastic, which foregoes the saving in finishing which the plastic is supposed to effect.

One experience, however, deserves mention, namely, the promising results reported in efforts to use plastics in place of wood or steel in aircraft fabrication. (See MECHANICAL ENGINEERING, July, 1939, page 546.) The author points out that plastics have a definite and highly important place in the industrial picture. Their primary uses, however, are to supplement and not to displace metals.



CAMERA USED TO REPRODUCE DRAWINGS ON WOOD, METAL, PAPER, AND CLOTH

(A new process by which engineering drawings are directly reproduced, photographically, on nearly any kind of surface is now being used by the Glenn L. Martin Aircraft Co. An extremely large camera snaps pictures of large drawings, the negatives are developed, and the images projected back to large sheets of wood, metal, paper, or cloth, whose surfaces have been sensitized with a special emulsion. When such a sheet—the maximum standard size is 5 × 10 ft, but it can be larger—is developed, the drawing appears in exact scale, or in fractional or multiple scales if it appears desirable. In the view shown, fixtures, jigs, etc., are no longer built from scale drawings but are constructed directly on the full-scale drawings themselves; the workmen simply follow the lines of the photographic print.)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Canadian Mine Hoists

COMMENT BY J. HUNT[1]

This paper[2] shows the progressive improvements which have been made in the design of hoist auxiliaries, clutches, brake paths, and engines. It also shows the trend in the use of roller bearings, with the accompanying reduction in power and principal hoist dimensions. However, the authors neglect to mention the use of tandem drive, which is gaining in popularity because it enables the hoist to be used economically at shallow depths with one motor installed and, as conditions require, the installation of a similar motor in tandem.

COMMENT BY R. D. PARKER[3]

With the positive-type clutch it is difficult to machine the mating members accurately enough to avoid a slight backlash when the skip is leaving the dump. This, however, can be taken care of in the space-type gear clutch by installing an extra fitted tooth on each arm shown in Fig. 2*b* of the paper.

The data on the Nordberg hoist at Creighton No. 5 shaft refers to a skip. This is a cage hoist with cages weighing 13,000 lb, handling a maximum load of 13,000 lb, and giving a total rope pull of 49,100 lb.

In writing the paper, the authors might well have included information on the desk-type control, brake control, drum grooving, and risers for carrying the rope from one layer to the next.

COMMENT BY J. A. RUSSELL[4]

The authors have given a valuable summary of the trend of hoist design in the ore mines of Canada. It is interesting that in the coal mines of the Dominion Coal Company the tendency has been, in many details, in the same direction.

Brakes, for instance, have advanced from the band brake found on older hoists, first to bottom-pivoted post brakes, and it is now pretty well accepted that parallel-action post brakes are by far the most satisfactory. Large brakes are all gravity-applied and air-released.

Brake blocks are usually of noninflammable material, invariably so on underground machines. On large hoists heating of the brake paths has been a serious problem. Ventilated paths of the usual type have not been entirely satisfactory, as steel treads score and groove, while nickel-iron treads, unless made in very short sections, crack very badly. We have not yet used the "Cramp" brake path. This appears the most promising solution of the problem that has yet been offered.

Clutches of the band type have been supplanted (in some cases actually replaced) by internal-gear positive clutches and more recently by the face-gear type. In one instance of full-circle internal-gear clutch which was engaged and disengaged very frequently, considerable difficulty was experienced with seizing and tearing of the metal in the clutch teeth. After the clutch had been removed from the hoist and about half the teeth machined off, leaving four segments 90 deg apart, the trouble practically disappeared. It is probable that minute inaccuracy of pitch was the original defect.

The development of submarine coal mines by slopes of moderate inclination has led to the use of a type of hoist not mentioned in the paper, namely, the large slope hoist. Of these the Dominion Coal Company has seven, three steam hoists and one electric on the surface, and three electric underground. Perhaps it should be explained that because the limit of economical slope hoisting is about 8000 ft (slope measure), and mines below the sea bed prevent the sinking of new shafts or slopes nearer the coal face, large hoists have been installed underground to relay the coal to the main hoists. These machines all have the same broad characteristics and a brief description of the latest, the relay hoist in our No. 16 mine, will be indicative of the present development of the type. This hoist, installed in the spring of 1939, is located in a house 1280 ft below sea level and about 1700 ft to seaward of the shore line.

The machine, built by the Dominion Engineering Co., has two drums independently clutched for hoisting in balance 25 cars of coal, each 5000 lb gross, up a 20 per cent slope at 1500 fpm mean rope speed. The drums are of cast steel each in four pieces, being jointed along the axis of the shaft and at right angles to the shaft midway between the flanges. This design has been found by far the most satisfactory for coiling, as in this case, 8000 ft of $1^1/_4$-in. rope under a tension of 35,000 lb. Each drum is 8 ft in diameter on the barrel, 4 ft $3^1/_2$ in. wide, with flanges 10 ft 10 in. in diameter, to accommodate eight active layers and one complete dead layer of rope, the latter being used instead of grooving the drum.

Clutches are of the face-gear type sliding on hexagons and operated by air cylinders. Clutch-brake interlocks cannot be fitted to this type of hoist, but the clutches are locked so that they cannot creep either in or out of gear when the air is off the cylinder.

Brakes are parallel-post brakes gravity-applied and released by air engines with Iverson-type valve gear. Paths are ventilated and brake linings are of asbestos 2 in. thick.

Gearing from the 590-rpm motor is double-reduction, double-helical, running in oil.

Roller bearings were very seriously considered for this hoist. Their use would have led to a reduction in dimensions, which was extremely desirable. The construction of a large hoist house in the strata found in the vicinity of coal is both difficult and expensive. In the present case 50 tons of fabricated steel were used to support the roof over a hoist, the mechanical parts of which weighed 80 tons. The roller bearings were finally rejected because of the difficulty, one might almost say the impossibility, of replacing a defective bearing underground.

The hoist is fitted with Lilly controllers and the usual safety devices, including a slow-braking device to apply the emergency brakes very slowly if they trip out

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[1] Falconbridge Nickel Mines Limited, Falconbridge, Ontario, Canada.

[2] "Canadian Mine Hoists," by H. V. Haight and G. M. Dick, MECHANICAL ENGINEERING, December, 1939, pp. 885–891.

[3] General Superintendent, The International Nickel Company of Canada, Ltd., Copper Cliff, Ontario, Canada.

[4] Chief Mechanical Engineer, Coal Division, Dominion Steel & Coal Corp., Ltd., Sydney, Nova Scotia.

during the high-speed portion of the wind.

The principal dimensions of this relay hoist are: Drum diameter, 8 ft; drum width, 4 ft $3\frac{1}{2}$ in.; maximum pull on one rope, 35,000 lb; diameter of rope, $1\frac{1}{4}$ in.; mean full speed, 1500 fpm; maximum length of hoist, 8000 ft; motor rating, 1500 hp; peak motor rating, 2140 hp.

COMMENT BY B. V. E. NORDBERG[5]

Mining in Canada has enjoyed a tremendous gain in the last few years and the development of projects requiring large hoisting equipment has grown more rapidly than our own in the United States. We have only one argument with our Canadian friends and it relates to the requirement for tooth clutches. Much thought has been given to this development and the paper clearly shows three types and an improvement in the tooth profile to attempt to overcome one great disadvantage of this type, viz., its slow application. A further disadvantage is its inability to space the up-and-down-going skip in precise location. Both of these disadvantages disappear with the use of the plate-type friction clutch. The cost of the friction clutch is necessarily higher and acquaintance with the operation of the toothed clutch, and willingness to put up with its disadvantages by virtue of becoming used to it, may be a reason for its continued use. However, we can hardly agree with the statement and its implication that the toothed clutch is in use on "largest hoists because it is safe." The largest hoist now being built for a Canadian mine is being equipped with a friction clutch, the safe holding torque of which is 575,000 ft-lb with wood lining. Its capacity can be readily increased and it is designed to take 850,000 ft-lb torque.

One of the largest hoist drums so far built was for the New Consolidated Goldfields Limited, South Africa. It is clutched to the hoist shaft by a disk-type tooth clutch, the pitch diameter of which is only 8 ft 4 in. and having 60 teeth. The drum is a cylindro-conical type, and has large and small diameters of 35 and 13 ft, respectively. The ratio of the drum diameter to the clutch diameter is large and spotting the skip within close limits for intermediate level hoisting is not very close.

The real reason back of the use of tooth clutches in South Africa probably dates back to the use and failure of band-type friction clutches, to which this paper refers, and which have a greater holding power in one direction than in the other. Such failures have led to a mistaken idea that friction clutches are incapable of the safety that is possible with the tooth clutch. British manufacturers who supply South Africa with hoisting equipment have developed tooth-clutch types and in offering hoists to Canada have set a precedent or style which is still being followed. Our Canadian friends, with but few exceptions, are today taking a broader-minded view of the matter and friction clutches are not looked upon as less safe, but simply more expensive, and because of being more desirable are demanded when the expense can be evaluated in terms of utility or convenience.

Many large hoists in the United States have no clutches at all, even though hoisting must be done from several levels. We refer to the practice in the copper country of northern Michigan. Friction clutches were looked upon with fear for the deep shafts necessary in that locality and were consequently avoided. It is interesting, however, to note that some of the earliest hoists of the Calumet & Hecla Mining Company, Calumet, are clutched to a common shaft, driven by a large central steam engine, these clutches being the notorious band type. Each drum raises a cage or skip, unbalanced, in a shaft and lowering is done on the brake. By this means the band clutch acts in one direction only and has given no trouble for this reason. It is a glaring inconsistency that may justify the general later policy.

The tooth-type clutch shown in Fig. 2*c* of the paper was proposed to the Canadian Mining & Finance Co. during the middle of 1916 and again to Rand Mines, Ltd., in the fall of 1923 and reference to this clutch as a type being devised by Mr. Cramp is not accurate. To Mr. Cramp belongs the credit of having used this type of tooth clutch, which lends itself to modification of the teeth, as disclosed in Fig. 5 of the paper. It offers a means of more easily meshing the teeth of the clutch, although some means of slipping the brake while the teeth become engaged seems necessary.

Several drums of composite construction have been used in the Canadian mining fields and have partially failed, due either to strains remaining in the structure or to the heavy loads imposed on the drums, or both. The failures of these drums, made by British manufacturers, indicate that a plate drum structure must be properly designed and manufactured to stand up in continuous service. When properly constructed, it is a type to be preferred particularly when heavy loads are to be handled. Such drums have been built in sufficient numbers and have operated over a sufficient length of time to indicate their advantage. More might be said on this subject and it is to be regretted that the paper does not cite the use of such drums in Canada.

AUTHORS' COMMENT

The authors appreciate the various points brought out by those taking part in the discussion and only regret that space in the original paper did not permit including some of the interesting features which have been mentioned.

By "tandem drive," Mr. Hunt draws attention to an interesting practice, namely, using two electric motors coupled to two pinions, one located at each side of the gear. This permits installing one motor initially for shallow depths and a second motor later when it is necessary that the ore be handled from lower levels.

Mr. Parker's comments on the positive-type clutch give one of the reasons why the newer design of internal expanding positive clutch was developed. In the latter the backlash can be controlled to any desired amount by means of the adjustments provided radially. Space restrictions prohibited a more comprehensive survey to include some of the recent developments such as desk-type control, etc.

Mr. Russell's contribution covering coal-mine hoisting practice and developments is very interesting and touches a phase of the subject which is somewhat of a departure from the regular ore-hoisting problem. As a general rule it has been found that coal-mine haulages have more severe service than the usual ore hoists and for this reason even more rugged and substantially built hoisting equipment is required if continuous, trouble-free operation is desired.

We appreciate the discussion of our paper by such a leading designer of hoists as Mr. Nordberg. We are not disposed to defend strongly the positive clutch as safer than the plate clutch; however, many of our customers think the positive clutch is safer.

In reference to the tooth-type clutch invented by D. L. Cramp and illustrated in Fig. 2*c*, Mr. Nordberg says "reference to this clutch as a type being devised by Mr. Cramp is not accurate." Mr. Cramp convinced the U. S. Patent Office that he was the inventor and U. S. Patent 1,946,062, which was dated Feb. 6, 1934, was issued to him, as well as a Canadian patent.

Mr. Nordberg says that several composite drums of British manufacture have "partially failed." On the other hand a cast drum of U. S. manufacture, at a

[5] Executive Engineer, Nordberg Manufacturing Co., Milwaukee, Wis. Mem. A.S.M.E.

Canadian mine, was a sudden and complete failure. We do not know of any hoist drum of Canadian manufacture that has had to be replaced. There have been cases, in early designs of composite drums, where the longitudinal joint had small bearing area and began to crush. These drums were made good by stiffening ribs. But we have no evidence that stiffening ribs are necessary in a composite drum where the outer plate is thick enough to stand the compression. The stresses in the barrel and flanges of hoist drums might well form the subject of an engineering paper. Small model drums, furnished by hoist manufacturers, might be tested to destruction.

H. V. HAIGHT.[6]
G. M. DICK.[7]

Developments in Domestic Heating

COMMENT BY ANDREW A. BATO[8]

Speaking of anthracite as a fuel for domestic heating,[9] Mr. Johnson brought out a few points which are not peculiar to anthracite at all as they might be mentioned in connection with any other fuel just as well. For example, the author states that the building benefits by the radiant heat of the boiler and by the heat of the flue gases inasmuch as both contribute to the heating of the building. He also mentions the possibilities of panel and floor heating and improvements in the heat insulation of the buildings. These points apply equally well in the case of the other fuels discussed in this symposium. Buildings are heated by steam, hot water, or hot air and, other conditions being equal, it should make no difference how these agents are generated.

On the other hand the method of generating steam, hot water, or warm air has a very great influence on the success of the installation. Here again it is not the fuel itself which counts but the regulation of the combustion equipment. When surveying the equipment available on the market at present, we find that anthracite-burning installations offer a distinct advantage from the point of view of regulation. This advantage is to be ascribed not to the ingenuity or thoroughness of the designers but to an inherent quality of the solid fuel. This quality emanates from the fact that, while oil-burner installations for light oil are regulated by the "off-and-on" method, the fuel bed of anthracite is never entirely "off," which contributes materially to the uniformity of heating in time as well as in space.

Consider, for example, the case of a two-story one-family house heated by a single-pipe steam system. This system has the disadvantage that the steam valves must be either fully open or fully closed. Half closing of the regulating valves will result in a continuous noise due to water hammer. The thermostat is usually installed either in the hall or in the living room, that is, it will react to a temperature produced by the radiator nearest to the boiler. Suppose now, the thermostat being set for 70 F, that the temperature in the living room reaches this level, and the thermostat accordingly shuts off the oil burner. The first room to cool off due to lack of steam will be some remote room on the second floor. When the temperature in the living room drops, let us say, to 68 F, the thermostat will cause the oil burner to ignite again. The same remote room will be the last one to get steam and, in an extreme case, it may happen that the thermostat will shut off the steam again before the remote room can get any steam at all. In case of a two-pipe system, a careful setting of the modulation valves of the radiators may remedy the situation. In the case of a single-pipe installation the only help would be to install orifices equalizing the supply of steam.

If an anthracite fire is controlled by a thermostat which regulates a damper, or starts and stops a forced-draft fan, the situation may still be bad but not as bad as in case of a flame that is shut off altogether.

The remedy for oil burners is to install a "high-low flame" or modulation regulation with compensation, to float on the load. Such installations are becoming more and more frequent in industrial plants. They are comparatively inexpensive; a 200- to 300-hp boiler can be equipped at a cost of about $150. There is no reason why oil burners to be used for domestic heating could not be equipped likewise.

As long as the abrupt on-and-off regulation is used, it is advisable to secure the cooperation of an experienced heating engineer in addition to that of the combustion expert.

The advocates of liquid fuels should thank Mr. Johnson for pointing out the significance of the uniformity in heat liberation.

[6,7] Canadian Ingersoll-Rand Company, Ltd., Sherbrooke, P. Q., Canada.

[8] Consulting Engineer, East Orange, N. J. Mem. A.S.M.E.

[9] "Anthracite as a Fuel for Domestic Heating," by A. J. Johnson, MECHANICAL ENGINEERING, March, 1940, pp. 208–210. This is paper No. 3 in a symposium on the subject, "Developments in Domestic Heating."

AUTHOR'S COMMENT

Mr. Bato's remarks in connection with the author's paper[9] are considered to be a valuable addition to the paper itself and to amplify several points ably.

The author recognizes the fact that the ideals of heating as discussed in his paper are susceptible to solution by fuels other than anthracite. It was his purpose, however, to point out that anthracite met these requirements with a minimum of equipment and with the greatest surety of success. Mr. Bato clearly explains this viewpoint and in addition, the author agrees that oil equipment might be equipped with modulated controls but the fact remains that such controls are, as of this date, almost unheard of in connection with the domestic heating to which the paper referred.

ALLEN J. JOHNSON.[10]

COMMENT BY WILLIAM G. CHRISTY[11]

Despite the vast strides made in power-plant design, domestic-heating equipment[12] has lagged behind until the last few years. Even today, many conversion burners and stokers are being installed in heating boilers designed for hand-firing with anthracite. Many of these boilers are not well suited for mechanical firing. Thousands of boilers and furnaces designed for anthracite are still being sold for hand firing with bituminous coal, thus causing much of the smoke pall hanging over many of our cities. Progress is now being made to eliminate this condition. There are on the market today very good designs of heating boilers and furnaces for gas, oil, and stoker firing.

Some figures presented in this symposium indicate the vast increase in mechanical firing of domestic heating plants during the last 10 years. Twelve years ago, about 5000 stokers were installed annually in this country. Sales increased each year until, in 1938, they reached nearly 100,000. The public evidently wants automatic heat and is willing to pay for thermostatic control. An interesting development in domestic heating has been the tremendous increase in mechanical firing together with the design and production of better boilers, furnaces, burners, and stokers.

One of the drawbacks of designing

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[12] "Domestic-Heating Boilers for Automatic Firing," by L. N. Hunter, MECHANICAL ENGINEERING, March, 1940, pp. 203–206. This is paper No. 1 in a symposium on the subject, "Developments in Domestic Heating."

heating systems has been the uncertainty of boiler ratings. Conditions were so bad at one time that many contractors and heating engineers selected a boiler the rating of which was at least double the load. Various formulas for rating boilers have been devised. These have been based on heating surface, grate surface, bulk of boiler, and, sometimes, other physical characteristics. Some formulas have included factors for various fuels, with allowances for mains and risers, pickup, attention, etc. It would seem to mechanical engineers, that a system of rating based on tests is preferable. The Technical Committee of the Institute of Boiler and Radiator Manufacturers is to be congratulated for the very constructive work they are doing on the rating of cast-iron boilers. They have drawn up their own test code and rating code. Boiler ratings for both hand firing and mechanical firing will be based on tests.

The papers presented in this symposium indicate some of the factors involved in the selection of fuel and type of firing for domestic heating. Naturally, the market price of various fuels in a community is a primary consideration. Then too, it is important for the owner to decide just how much automatic control he wants and how much labor he desires to eliminate.

Owners and operators of heating plants should give them more attention. For instance, when an oil burner is installed, the owner is often too prone to think that all he needs to do is to keep oil in the tank. So many owners do not realize that mechanical equipment should have attention and service. Any domestic burner or stoker should be inspected and serviced periodically. When mechanical-firing equipment is installed, better results will be obtained if a new heating furnace or boiler, designed for the particular fuel, is also installed. It is well to make sure that the heating equipment is large enough to handle the load.

COMMENT BY HERBERT G. SCHAUL[13]

Mr. Segeler in his paper[14] has admirably covered the progress and the future of gas heating in an unbiased manner backed up with facts proved by innumerable gas companies.

To the writer several points stand out as worthy of discussion from the viewpoint of one who has been closely associated with the active selling of the gas-heating load over a number of years.

"Comfort heating" is no idle term when it covers the wide range from small four-room houses to veritable mansions; specific accent being made on comfort to the owner. This is particularly borne out by the trend in various sections of the country toward the construction of small houses for the lower-income group. In Westchester County, New York, for example, we have a group of four-room houses which averaged $67.80 for gas heating during last winter. Even in this type of home, automatic heating is demanded and expected for comfort results.

The magic of the term "air conditioning" and its public acceptance have done much toward the success of the present trend to winter air conditioning. Again, the public demands the new method of heating which will control heating, humidification, filtration, and circulation of the air within their homes.

Mr. Segeler very aptly sounds a note of warning against inferior workmanship, design, and installation of these systems. The results from the use of the "Gasco Guide"[15] in securing better installations has been most encouraging. Furthermore, it has helped the owner in securing a good heating installation. Consequently, competition has been forced to bid on the basis of good installation practices and not on inferior workmanship.

Whether or not summer cooling equipment is added to the winter air-conditioner, the fact that air circulation is provided in the summer for comfort, has been of material assistance in selling the load. The general use of insulation has assisted the case.

Industrial Marketing

COMMENT BY ROBERT T. KENT[16]

The three papers on marketing[17] by Professor Bangs and Messrs. Heitkamp and Gibson represent the initiation of a movement in the Society affairs, which, if carried to a positive conclusion, may be almost as epochal as Taylor's paper[18] on cutting metals. By the publication of that paper, the Society revolutionized machine-shop practice throughout the world. The principles laid down by Taylor in the paper just cited and in his classic work[19] on shop management, presented before the Society a few years earlier, were at the time held to apply to production only. In the years that have passed, we have learned that Taylor's fundamental principles apply to every phase of industrial and business endeavor. They apply equally well to the problems of marketing as they do to the problems of the machine shop. It is a healthy sign that the A.S.M.E. has at last recognized the fact that it has a mission to fulfill in promulgating these principles in a field which is just as vital to industry as is the production field. If there are no markets there will be no production. It goes without saying, therefore, that anything which can be done to improve marketing methods has a direct effect on all other activities of a business enterprise.

Marketing in an engineering enterprise is concerned very largely with two phases, namely, sales engineering and market analysis. One reason perhaps why these two branches of the marketing problem have not received attention commensurate with their importance is that they have been treated as separate entities, that is, they have not as a rule been tied into the general management policy of the organization. The function of the sales engineer, for example, is to acquaint the customer with the best method of solving the customer's problems by the use of the product of the salesman's company.

Sales engineers can, and very frequently do, make important contributions in the design of equipment and have saved thousands of dollars for the customers of their firms. They have been instrumental in the development of new products for their companies and for new uses of old products. On the other hand, sales engineering, if allowed to run loose, may cost the organization thousands of dollars which never can be recouped. For example, consider a highly standardized line of equipment that is being manufactured almost on a mass-production basis and at a low margin of profit. The net profit available for dividends depends almost entirely upon the volume of production. This volume may very easily be upset and the profit eliminated by the injection into the manufacturing schedule of modifications of this standard

[13] Manager, House Heating Division, Westchester Lighting Company, Mount Vernon, N. Y.

[14] "Gas Heating," by C. G. Segeler, MECHANICAL ENGINEERING, March, 1940, pp. 212–214. This is paper No. 5 in a symposium on the subject, "Developments in Domestic Heating."

[15] "Gasco Installation Guide," available from the American Gas Association, New York, N. Y.

[16] Consulting Engineer, Clarke-Harrison, Inc., Philadelphia, Pa.; General Manager, Wm. Sellers & Co., Philadelphia, Pa. Mem. A.S.M.E.

[17] "Industrial Marketing," comprising abstracts of papers, "The Marketing Movement in Mechanical Engineering," by J. R. Bangs, Jr.; "Gearing Engineering to Sales," by F. B. Heitkamp; "Market Research in Introducing New Industrial Products," by R. L. Gibson, MECHANICAL ENGINEERING, March, 1940, pp. 215–218.

[18] "On the Art of Cutting Metals," by F. W. Taylor, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, N. Y., 1907.

[19] "Shop Management," by F. W. Taylor, Trans. A.S.M.E., vol. 24, 1903, pp. 1337–1456; and also McGraw-Hill Book Co., Inc., New York, N. Y., 1911.

equipment or by the attempt to design and build special equipment with which to meet the peculiar needs of a particular customer.

A good salesman usually views the order and the net profit resulting from that particular order as the only important considerations. The average sales manager has the same point of view. As a rule, neither one attempts to fit the modified standard product or the special product into the general picture of the company's output nor analyzes the effect on gross and net profit of the disruption of a carefully planned standard manufacturing program.

Nor is it their function to make this analysis. It is the function of management to decide whether or not it is profitable to depart from the recognized standards and chase the will-o-the-wisp of special products. It is in this respect that management frequently is lax and is subject to criticism. It takes nerve sometimes for management, particularly in times of declining business, to turn down an order which apparently carries a handsome net profit. However, a careful analysis of all that the filling of such an order will involve may show that the so-called profit actually means a loss at the end of the year. This brings us, naturally, to the relation between management and the sales-engineering and the market-analysis problems.

The function of management is to lay down the general policy under which the organization shall operate. Its active duty is to coordinate and balance the functions of the several departments, e.g., finance, purchase, production, and sales. If sales, purchase, and production become unbalanced, an undue burden is thrown upon the financial division and actually may result in lost profits, notwithstanding the large volume of apparently profitable business. It is here that market analysis plays an important part.

Market analysis, as generally considered, is the study of the field available for the marketing of new products. This, in the writer's opinion, is the least important part of market analysis. A company will make money much more rapidly on an old established line of products than it will on a new product. Not only is there the sales resistance inherent in new and untried things but there is also promotion expense, design expense, tool expense, and everything else which goes into the development and manufacture of something that has not been made before. All of these expenses must be absorbed by the product within a given period. Unless they can be so absorbed, they decrease the surplus by the amount of unabsorption. On the other hand, in an endeavor to absorb them all, prices may necessarily be raised to a level which creates even more sales resistance and thereby diminishes the expected volume. Of course, good and careful market analysis will take into account all of these factors, and management, if it utilizes the analysis in the proper manner, will be on its guard against being led into unwise expenditures on new products.

The most important part of market analysis is that applied to old products and standard lines. Such analysis will reveal changes in market trends, the development of competitors' products which may possess advantages over the company's own products, or it may reveal an industrial competition whereby something entirely different is in the offing, which may completely displace the present product. Today, for example, natural ice has largely been displaced by mechanical refrigeration in the home.

Market analysis on current products has a direct relation to the budget. As a matter of fact, it is the basis of the budget. Management may not recognize it as such, but the customary sales forecast, which management calls for at the beginning of every budget period, is nothing more nor less than a crude sort of market analysis. It has long been a complaint of management that, while it is possible to forecast production, wage rates, material prices, and other items which account for the expense side of the budget, the man does not live who can accurately forecast the sales, that is, the income side of the budget. And yet, if the same searching analysis were put into the possibilities of marketing current products as is put into the marketing of future products, the sales forecast would be a highly accurate and usable tool, and budgets would not need to have the flexibility that is required of them today.

It is the duty of management, therefore, to tie sales engineering, market analysis, sales forecast, and everything else that has to do with the distribution of its product into the budget. Having done this, management would find its job a much easier one to perform.

Wearing Gloves Unsafe

TO THE EDITOR:

My attention was attracted to a picture in the June issue of MECHANICAL ENGINEERING entitled "Machinist in Locomotive Works."

It might have been appropriate for this title to have read "Machinist in Locomotive Works Indulging in Unsafe Practice." Wearing gloves while operating machines constitutes a hazard which should be avoided wherever possible.

The Norfolk & Western Railway Company's safety rules prohibit the use of gloves when operating machinery or machine tools, except where gloves are required in the handling of rough materials such as on forging machines, steam hammers, and flue welding machines. It is so much better for the workman's hands to be soiled or even scratched slightly than for him to lose an arm because of the glove's catching in the moving machine.

G. P. McGAVOCK.[20]

[20] Roanoke, Va.

A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and also published in MECHANICAL ENGINEERING.

Following is a record of the interpretation of this Committee formulated at the meeting of May 17, 1940, which was subsequently approved by the Council of The American Society of Mechanical Engineers.

CASE No. 684

(Annulled because of adoption of Case No. 898)

CASE No. 792

(Annulled)

(Interpretations continued on page 623)

CASE No. 834

(Annulled because of adoption of Case No. 897)

CASE No. 836

(Annulled because of adoption of Case No. 897)

CASE No. 861

(Annulled because of adoption of Case No. 897)

CASE No. 892

(*Interpretation of Pars. P-197a and U-38a*)

Inquiry: According to Pars. P-197*a* and U-38*a* there is permitted during the forming of a head, a thinning down at the corner radius of the knuckle of 10 per cent of the nominal required thickness. Is this allowable decrease in thickness applicable to all dished heads, including semi-ellipsoidal and hemispherical, and to the entire head—not the knuckle portion only?

Reply: It is the opinion of the Committee that the reduction in thickness permitted by Pars. P-197*a* and U-38*a* is applicable only to heads each consisting of a segment of a sphere encircled by part of a torus constituting the knuckle, and only to the torus (knuckle) portion.

CASE No. 895 (Reopened)

(*Interpretation of Specification S-48*)

Inquiry: Pending the adoption of a change in A.S.T.M. Specifications A209-38T, which is identical with Specification S-48, will it be permissible, in manufacturing superheater tubes by the forge welding process, to use a minimum carbon content of 0.08 per cent and a minimum manganese content of 0.25 per cent for grade T1 instead of a minimum carbon content of 0.10 per cent and a minimum manganese content of 0.30 per cent as required, provided the material meets all other requirements of the specifications?

Reply: It is the opinion of the Committee that lower carbon and manganese contents may be used for grade T1 material complying with Specifications S-48 under the conditions set forth in the inquiry.

CASE No. 896

(*Special Ruling*)

Inquiry: Is it permissible to use chrome nickel clad steel for the construction of unfired pressure vessels where the cladding material conforms to A.S.T.M. Specifications A167-39, grades 5 or 6, modified as follows:

Carbon, max, per cent	0.07
Manganese, per cent	0.40–2.50
Chromium, min, per cent	17.00
Nickel, min, per cent	9.50
Columbium, min — 10 times carbon content	1 per cent max
Titanium, min — 6 times carbon content	0.60 per cent max

The carbon analysis shall be considered to the nearest one hundredth of one per cent. Either columbium or titanium may be used. Case No. 897 permits the use of plate made of this stainless steel in full thickness.

Reply: It is the opinion of the Committee that stabilized austenitic chrome-nickel steel of the composition specified in the inquiry may be used in the construction of unfired pressure vessels provided that all Code requirements covering design, welding, and tests for the class of service for which the vessels are intended are complied with, as well as the following requirements:

(*1*) The base plate material shall be in accordance with an approved steel-plate specification, the required tests being made of specimens with the clad material removed. The bend test shall be made with the clad side in tension;

(*2*) Additional tension tests shall be made of the composite clad plate which shall meet the minimum requirements of base specifications. Two bend tests shall be made of the composite clad plate one having the clad material in tension and one having it in compression;

(*3*) The full thickness of the composite plate may be used in design calculations for Par. U-68 vessels provided the service temperature is below 250 F, and for other vessels provided that both the service temperature is below 250 F and the service pressure is below 100 lb. For all other vessels the thickness of the carbon steel base plate only shall be used in design calculations;

(*4*) The welding process qualification tests, the welding operator qualification tests, and the production test plates of Par. U-68 vessels shall include two free-bend specimens, one of which shall be tested with the cladding in tension and the other in compression. Both shall meet the elongation requirement, measured over a gage length of not less than $^1/_2$ in. including the weld, for the class of construction required;

(*5*) The welds are completed before radiographing where this is required;

(*6*) The types of joints used be such that steel weld metal shall not fuse into the stainless layer and the depth of the stainless bead be kept to a minimum;

(*7*) No fillet weld be allowed in longitudinal or girth joints except for dished heads of Par. U-70 vessels convex to pressure (See Fig. U-14*c*).

It is important that the completed welds have a corrosion-resistant property substantially equal to that of the stainless cladding. Until such a time as suitable rules to test corrosion-resistant properties of welds are formulated, the manufacturer should satisfy the purchaser that the weld is suitable for the intended vessel use. Austenitic chrome-nickel stainless steels, when in a condition of internal stress and exposed to certain aqueous chloride solutions may fail by stress corrosion cracking. Consideration should be given to the possibility of stress corrosion cracking in this and other corrosive environments to which the vessel may be exposed. For operating temperatures in excess of 250 F, consideration should be given in the design of vessels to the effect of thermal stresses arising from the difference in coefficients of expansion of the two materials.

CASE No. 897

(*Special Ruling*)

Inquiry: May chrome-nickel steels as such, or alloyed with columbium, titanium, or molybdenum, be used in the construction of unfired pressure vessels under A.S.M.E. Code rules?

Reply: Chrome-nickel steels as such, or alloyed with columbium, titanium, or molybdenum, may be used in the construction of unfired pressure vessels under the Code without consideration for their corrosive properties, with the following limitations:

(*1*) It is expected that vessels of alloy steels covered by these rules will be used to hold liquids and gases corrosive to ordinary materials, but the selection of an alloy suitable for the vessel's contents and the determination of corrosive allowances is not covered by these rules.

It is recommended that users assure themselves by appropriate tests, or otherwise, that the alloy selected and the treatment following fabrication are suitable for the service intended.

Where service data are not available, the procedure of Par. U-11*b* should be followed.

(*2*) *Specifications.* The alloy chrome-nickel material shall conform to A.S.T.M. Specifications A167-39 for sheets and plates, of only the grades tabulated below and subject to the following added restrictions and requirements. Structural shapes, bars, tubes, pipe, and forgings made to the same specifications, so far as applicable, may be used.

a Chemical Composition. These alloys

shall conform to the following chemical composition:

A.S.M.E. Class	S	M	C	T
A. S. T. M. Grade modified	3	11	6	5
A.I.&S.I. Type modified	304	316	347	321
Carbon, max, per cent	0.07	0.07	0.07	0.07
Chromium, min, per cent	18.00	17.00	17.00	17.00
Nickel, min, per cent	8.00	9.50	9.50	9.50
Molybdenum, min, per cent	...	2.00	...	...
Columbium, per cent	...	...	Min, 10 × C (1% max)	...
Titanium, per cent	...	...	...	Min, 5 × C (0.60 max)
Manganese, max, per cent	2.50	2.50	2.50	2.50
Silicon, max, per cent	0.75	0.75	0.75	0.75
Phosphorus, max, per cent	0.03	0.03	0.03	0.03
Sulphur, max, per cent	0.03	0.03	0.03	0.03

The carbon analysis shall be considered to the nearest one hundredth of 1 per cent.

b Mechanical Properties and Tests. Material after heat-treatment shall conform to the following:

Tensile strength, min, lb per sq in.	75,000
Yield strength at 0.5 per cent elongation in 2 in. under load, min, lb per sq in.	35,000
Elongation in 2 in. min, per cent	30

c Marking. (I) Except as specified in (II), the name or brand of the manufacturer, the manufacturer's test identification number, class of material (S, M, C, or T), and heat-treatment ((3)*a*, *b*, or *c*) shall be legibly stamped on each finished plate in two places not less than 12 in. from the edges. The manufacturer's test identification number shall be legibly stamped on each test specimen.

(II) For plates under 1/4 in. in thickness, the marking specified in (*a*) shall be legibly stenciled instead of stamped.

(3) *Heat-Treatment.* Heat-treatment of the completely welded vessel by one of the following procedures, (*a*), (*b*), or (*c*), is mandatory for all vessels built in accordance with Par. U-68 construction and for all vessels built in accordance with Par. U-69 construction when the plate thickness is over 1/2 in. Heat-treatment by one of the three methods is desirable for other vessels from the standpoint of corrosion resistance. For vessels not to be heat-treated after welding, the material shall be heat-treated by the appropriate procedure, (*a*), (*b*), or (*c*), as the last heating operation before welding. In this case the reduction of the corrosion resistance in the weld zone should be recognized. It is recognized that under some conditions of service vessels of any of the four materials covered by this Case which have not been heat-treated after fabrication give satisfactory operation from the corrosion standpoint.

a Heat the material or the vessel to 1900 to 2000 F for Classes S, C, and T, and to 1950 to 2050 F for Class M. Hold at this temperature for 1 hr per inch of maximum thickness, but in no case less than 1/2 hr. Quench all parts of the plate or vessel uniformly and as rapidly as possible. For Classes S and M the time consumed in cooling from 1700 to 1000 F shall not be more than three minutes. The rapid cooling shall be continued below this temperature.

NOTE: Austenitic chrome-nickel stainless steels, when in a condition of internal stress and exposed to certain aqueous chloride solutions, may fail by stress corrosion cracking. Consideration should be given to the possibility of stress corrosion cracking in this and other corrosive environments to which the vessel may be exposed, in cases where the vessels are to be quenched in accordance with the preceding paragraph.

b This treatment is applicable to Classes C and T only. Heat the material or the vessel to 1550 to 1650 F for Class T, and to 1550 F minimum for Class C. Hold at these temperatures for two hours per inch of maximum thickness, but in no case less than two hours. Cool in still air or in the furnace.

c This treatment is applicable to Class M only. Heat the material or the vessel to 1600 to 1650 F, holding sufficiently long to provide freedom from susceptibility to intergranular corrosion, and cooling in a still atmosphere. The holding time generally required for this treatment is at least 72 hr. The purpose of this heat-treatment is to place the vessel in a state of minimum internal stress, as well as to stabilize the steel.

(4) *Thickness Limitations.* Fusion welded, in inches:

Class	S	M	C	T
U-68	*a* 1 1/2	*a* 1 1/2 *c* None	*a* 1 1/2 *b* None	*a* 1 1/2 *b* None
U-69	3/4	3/4	3/4	3/4
U-70	3/8	3/8	3/8	3/8

(*a*, *b*, and *c* refer to heat-treatments under (3))

(5) *Pressure Limitations.* Pounds per square inch:

Class	S	M	C	T
U-68	...	...	...	...
U-69	400	400	400	400
U-70	100	100	100	100

(6) *Temperature Limitations.* Degrees Fahrenheit:

Class	S	M	C	T
U-68	−20 to 600	−20 to 600	−20 to 1200	−20 to 1200
U-69	−20 to 600	−20 to 600	−20 to 600	−20 to 600
U-70	−20 to 250	−20 to 250	−20 to 250	−20 to 250

These materials may be used at temperatures below −20 F provided the requirements of Par. U-142 are complied with. The allowable stress shall be the same as that given for −20 F to 600 F.

For operating temperatures above 600 F, Classes C and T should preferably be given the heat-treatment specified in (3)*b*.

(7) *Allowable Working Stresses.* Allowable working stresses in pounds per square inch shall be not in excess of the following values:

Class	For metal temperatures not exceeding deg F									
	−20 to 600	700	750	800	850	900	950	1000	1100	1200
S	15,000	...	...	...	...	...	...	...	...	...
M	15,000	...	...	...	...	...	...	...	...	...
C	15,000	15,000	14,000	13,000	12,000	11,000	10,500	10,000	5600	3200
T	15,000	15,000	14,000	13,000	12,000	11,000	10,500	10,000	5600	3200

(8) *Welding.* Welding shall be done and weld tests carried out in accordance with the provisions of Pars. U-68, U-69, and U-70, respectively, with the following additional requirements:

a The welded test plates for Par. U-68 construction shall include an additional free-bend specimen, and for other vessels that require heat-treatment there shall be provided a similar welded free bend specimen, which after heat-treatment shall be given the acid-copper-sulphate bend test as specified herein.

b The welded test plates shall be made from the same lot of material as the vessel itself.

c The test plates shall be heat-treated with the vessel for Classes S and M, but may be given a separate treatment for Classes C and T, provided the same heat-treatment is given the test plate and the vessel. In either case, the treatment given the test plates shall duplicate, as closely as possible, the physical conditions of the material in the vessel itself.

d The free-bend test specimen shall be ground and polished. Immerse in a boiling copper-sulphate sulphuric-acid solution for a minimum of 72 hours for

Classes S, M, C, and T. This solution shall consist of 47 cc concentrated sulphuric acid and 13 grams of crystalline copper sulphate ($CuSO_4 \cdot 5H_2O$) per liter of water. The sample shall be bent so as to confine the bend to a point $^1/_4$ in. from the edge of the weld in the base metal, and the least elongation in the outer fibers measured across the weld shall be not less than 20 per cent. After bending, the metal shall show no sign of disintegration.

e Composition of the deposited metal shall be within the following limits: Chromium, nickel, and molybdenum contents shall be within the same range as the parent metal. When columbium is used as a stabilizing element in the weld metal, it shall not exceed 1 per cent and shall be at least 9 times the carbon content of the weld metal for Par. U-68 vessels, and 8 times the carbon content for Par. U-69 vessels. When titanium is used as a stabilizing element of the weld metal, it shall not exceed 0.6 per cent and shall be at least 4.5 times the carbon content of the weld metal for Par. U-68 vessels and 4 times the carbon content for Par. U-69 vessels. The carbon content of the weld metal for Classes S, M, C, or T shall not exceed 0.08 per cent. Carbon shall be determined to the nearest one hundredth of 1 per cent.

(*9*) *Seamless Forgings.* Seamless forgings of the composition and mechanical properties specified in (*2*)*a* and (*2*)*b*, and made to the general requirements of Specification S-4, except that the process shall conform to A.S.T.M. Specifications A167-39, when heat-treated in accordance with (*3*) may be used within the limitations given for Par. U-68 construction in (*4*), (*5*), and (*6*). A bend test specimen for the check test of heat-treatment shall be provided as a duplicate of the bend-test specimen required by Specification S-4 and shall be heat-treated with the vessel.

CASE NO. 898

(Special Ruling)

Inquiry: Is it permissible under the rules of the Code for Unfired Pressure Vessels to construct vessels subject to external pressure of any of the stainless steels that are covered in Case No. 897? The physical properties and operating characteristics of these stainless steels are sufficiently near to those of the steels now provided for in Par. U-120 to justify their use under similar allowable working stresses and restrictions.

Reply: The Committee has an investigation under way to determine the applicability of stainless steel to this form of construction. Pending a report therefrom, it is the opinion of the Committee that the stainless steels provided for in Case No. 897 may be used as the equivalent of the materials provided for in Par. U-120 with the same methods of computation and the same allowable working stresses.

CASE NO. 903

(Interpretation of Par. UA-22)

Inquiry: In manufacturing weld neck nozzles by welding a seamless tube or pipe neck to a standard welding neck flange, there seems to be no rule in the Power Boiler Code for locating circumferential weld with respect to the flange face. In the Code for Unfired Pressure Vessels, however, there is a rule for locating such welds when a flange is welded to the end of a vessel or pipe which is a similar construction (See Par. UA-22*d*). This rule requires the weld to be located at a distance from the back side of the flange equal to three times the actual thickness of the neck but not less than 1 in. (See Par. UA-22*e*). Will it meet the intent of the Power Boiler Code and the Unfired Pressure Vessel Code if such fabricated nozzles had these circumferential welds located at the same relative distance from the flange as designated by the American Standard for Steel Pipe Flanges and Flanged Fittings (ASA B16e-1939) shown as dimension "Y" regardless of the actual thickness of the neck?

Reply: It is the opinion of the Committee that if the circumferential weld attaching a flange to a nozzle as described is located in accordance with the dimensions given for "Welding Neck Flanges" in the American Standard for Pipe Flanges and Flanged Fittings (ASA B16e-1939), the intent of the Power Boiler Code and the Unfired Pressure Vessel Code will be met.

CASE NO. 904

(Interpretation of Table A-6)

Inquiry: May steel-welding neck flanges provided in the American Standard for Steel Pipe Flanges and Flanged Fittings (ASA B16e-1939) be used and meet the requirements of Pars. P-299, U-59, and UA-16 of the Code?

Reply: It is the opinion of the Committee that welding neck flanges as given in the American standard should have been included in revised Table A-6 and their use will meet the intent of the Code provided the welding meets the requirements of the Code for the particular vessel to which they are attached.

CASE NO. 905

(Special Ruling)

Inquiry: Is it permissible to construct welded vessels for use in the range of —150 F to 650 F under the requirements of Pars. U-68 and U-142 using copper chromium nickel steel of the following chemical composition and physical properties:

Carbon, max, per cent	0.12
Manganese, per cent	0.55 to 0.85
Phosphorus, max, per cent	0.04
Sulphur, max, per cent	0.04
Chromium, per cent	0.65 to 0.85
Nickel, max, per cent	0.75
Copper, per cent	0.45 to 0.65
Silicon, per cent	0.15 to 0.30
Tensile strength, lb per sq in.	60,000–70,000

All other requirements in accordance with Specification S-1.

The specification test bars are to be normalized and stress-relieved at 1100 to 1200 F prior to test. The Charpy impact requirements will conform to Par. U-142.

Reply: It is the opinion of the Committee that the material specified in this inquiry may be used within the temperature range specified provided the provisions of Pars. U-68 and U-142 are complied with, and the material be normalized before welding. The maximum allowable working stress shall be not more than 12,000 lb per sq in.

CASE NO. 906

(Interpretation of Par. U-72j)

Inquiry: Par. U-72*j* provides that the requirement for cleaning out the root of a butt joint weld prior to welding on the second side is "not intended to apply to any process of welding by which proper fusion and penetration are otherwise obtained and no impurities remain at the base of the weld." Par. U-73*a* provides, where a backing-up strip is used to make a butt weld equivalent to a double-welded butt joint, that "this type of joint shall be used only in cases where the inside of the weld is inaccessible for welding." Is this last-mentioned provision in conflict with the quoted wording in Par. U-72*j*?

Reply: It is the opinion of the Committee that the sentence quoted from Par. U-73*a* does not apply where the welding meets the requirements of Par. U-72*j*.

CASE NO. 907

(Interpretation of Par. U-73a)

Inquiry: With reference to the provisions in Par. U-73*a*, is it permissible on thin plates to reduce the requirement of $^1/_{16}$ in. reinforcement at the center of the weld on each side of the plate?

Reply: It is the opinion of the Committee that on plates with a thickness of $^1/_4$ in. and less, the weld reinforcement on each side of the plate need not exceed 25 per cent of the plate thickness.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Labor and Production

ORGANIZED LABOR AND PRODUCTION. By Morris L. Cooke and Philip Murray. Harper & Bros., New York, 1940. Cloth, $5^3/_4 \times 8^1/_2$ in., 277 pp., $2.50.

REVIEWED BY WM. L. BATT[1]

THIS book is written by two outstanding liberals in the field of management and labor—men not in any sense on opposite sides of the table so far as their views are concerned, although they represent two of the principal functions of the industrial structure frequently found in opposition. Their approach is one of optimism and hope; of their views, they say at the outset:

> This book represents the efforts of two Americans representing supposedly conflicting interests, labor and management, to seek out some of the bases for constructive industrial statesmanship. They are gratified to find so much common ground when the problems are considered calmly and objectively . . . . By these pages we give testimony to our unwavering faith in the democratic principle in government, in industry, in every-day personal relationships, and to the watch it keeps on freedom of spirit in each individual life.

The early chapters are largely a history of the industrial growth of the country and a review of the controversial practices of labor and employers, and provide a background for the picture of a modern technological society, in which labor and management may work constructively toward a larger opportunity for both. In reading these chapters I was forcibly reminded of the situation in England a hundred years ago. Parliament had, about 1825, passed a law removing the criminal onus from membership in a labor union, and the resulting turmoil between employer and employee was not entirely unlike the situation of the last few years. But it is important to note that it took England the next one hundred years to achieve a sound solution of her problems in this troublesome area.

The more debatable parts of this absorbing book begin with the discussion of collective bargaining in chapter 15. Here we find a tolerant and well-expressed statement of that problem whose importance has been growing steadily during the period of our industrial history. Progressive management will find it possible to agree largely with these statements not only of objectives but of methods.

I cannot agree, however, with the clean bill of health given by the authors in chapter 16 to the Wagner Act and its administration through the National Labor Relations Board. Through its overzealous pursuit of the objective of unionization, the Board has, in my judgment, made unnecessary friction between employer and employee. It has exchanged what should be largely a judicial function, for the role of prosecutor and jury, and has even endangered the eminently worth-while features of the Act itself.

In the discussion of closer employer-employee cooperation, I felt the distinction was not clearly made that management, in the last analysis, must be responsible for the conduct of the enterprise. Wise management, it is true, will create the open-door atmosphere which encourages employees to contribute suggestions toward betterment of the business. But we want nothing comparable to the old Soviet system of divided authority between workers and managers, which even they discarded as unworkable. While I am of course sure that the authors do not propose such a system, this chapter is not particularly clear in that regard, and the casual reader might conclude that the ideal relationship was one in which the responsibility of running a business was equally shared between employer and employee.

Chapter 19 is a comprehensive and well-stated review of the problems of the day. Perhaps more recognition could have been given to the progress already made in stabilizing employment and providing assurance of more regular earnings through the plans in operation in a number of businesses. It might have been pointed out also that in some companies, where regularized production seems out of the control of management because of wide fluctuations of demand, arrangements for employee overdrafts are provided and serve a somewhat parallel purpose. In still other cases, it is encouraging simply to note a steady growth of the consciousness of a responsibility to provide more uniform employment even when not much can be accomplished at the outset.

This book may well be required reading for all who have to do with the operation of industry and who anxiously desire to understand the point of view of labor as expressed by one of its most farsighted leaders. It is significant to see that he will agree with us in management on so many fundamentals: That we both recognize that labor as well as management must assume a responsibility of efficient, economical production; that in this sharing of responsibility lies the worker's greatest stake in industry. To the worker it means additional earnings through increased production and decreased waste. To management it results in lower costs, lower-priced goods, more sales, and more profits.

The realization of this objective, with labor and management properly functioning within their respective fields of responsibility, would be invaluable in the creation of more harmonious relations between workers and management. A united front between these two groups, whose interests are actually the same, would further open the door to their ability to speak with force to government. Some such close working arrangement is particularly vital to the country's welfare now that we are face to face with the huge task of building up our productive capacity for national defense.

[1] President, SKF Industries, Inc., Philadelphia, Pa. Fellow and Past-President A.S.M.E.

Plastics in Engineering

PLASTICS IN ENGINEERING. By J. B. Delmonte. Penton Publishing Co., Cleveland, Ohio, 1940. Cloth, 6 × 9 in., 616 pp., 101 figs., $7.50.

REVIEWED BY F. L. YERZLEY[2]

THE rapid growth of the engineering use of plastics has been due in no small measure to the acceptance of plastics by design engineers for a host of auxiliary gadgets on machines of various types. Consumer acceptance in turn has been

[2] Physicist, Charge, Physical Testing Rubber, E. I. du Pont de Nemours & Co., Wilmington, Del. Mem. A.S.M.E.

enthusiastic and has been reflected by an increase of demands made by engineers upon plastics for structural use. The book is offered by the author as a much needed guide for designers outside of the plastics industry. The author is at his best in describing the applications of plastics and he fulfills the main purpose of his book by a network of chapters outlining the procedure to be followed in the development of a practical design. Several of the chapters deal with molding problems, including shrinkage and the use of inserts. Others cover nonmetallic bearings, gears, cams, couplings, and clutches and one chapter is devoted to the machining and finishing of plastic materials. More than half of the book will thus be recognized by a designer as directly related to his way of thinking. Principles are illustrated with a comprehensive selection of commercial applications.

In other parts of the book the author has attempted to supply desirable background on the chemical constitution and physical nature of plastics. Certain broad classifications are possible, but details are changing so rapidly that they make treacherous text material. This is distinctly emphasized by the chapter on rubber-like materials, which is obsolete in many respects even at this writing. Although thought provoking the book can be charged with many inaccuracies largely traceable to deficient source material.

The author predicts great expansion of the plastics industry and it can be expected that this volume and other efforts of Mr. Delmonte will contribute to that growth.

Books Received in Library

PRINCIPLES OF MECHANISM. By F. Dyson. Third edition. Oxford University Press, New York, N. Y.; Humphrey Milford, London, England, 1939. Cloth, 5 1/2 × 8 1/2 in., 364 pp., diagrams, charts, tables, $4.25. The fundamental principles that apply to the moving parts of machines are presented in a comprehensive manner, adapted to the needs of students of engineering. There are many worked-out problems in velocity, acceleration, and many types of mechanisms, together with a large number of problems to be solved by the student. The present edition contains several new sections on special mechanisms and actions, for the more advanced students.

PRODUCTION AND UTILIZATION OF COKE. By F. M. H. Taylor. Walter King, Ltd. (*Gas Journal* Offices), London, E.C.4, England, 1939. Fabrikoid, 5 1/2 × 9 in., 278 pp., illus., diagrams, charts, tables, 21s. This work is specifically concerned with the utilization of coke and is intended as a guide to its combustion and use for heating dwellings and for raising steam, for gas production, and other purposes. The production and properties of coke and its preparation for the market are discussed briefly. Considerable space is given to the design and construction of coke-burning appliances.

QUANTITATIVE SPECTROGRAPHIC ANALYSIS WITH THE MICROPHOTOMETER. Part 1. A Review of Published Work, by D. M. Smith. Research Report, Association Series No. 524. November, 1939. British Non-Ferrous Metals Research Association, London, N.W.1, England. Paper, 6 × 10 in., 24 pp., tables, 2s. The work published in the last fifteen years on quantitative spectrographic analysis with the microphotometer is listed and reviewed briefly in this pamphlet. A tabular summary is given of data for the analysis of nonferrous alloys, and the present position of the method is summarized.

ROAD TO MODERN SCIENCE. By H. A. Reason. D. Appleton-Century Co., New York, N. Y., and London, England, 1940. Cloth, 5 1/2 × 8 1/2 in., 297 pp., illus., diagrams, charts, tables, $3. Important scientific achievements from the earliest recorded times to the present day are described in a concise, simple manner. Some account is given of the contemporary background and the lives of the men connected with the various discoveries. A chronological arrangement carries part I up to the time of Newton. Part II, 1600 to date, takes up each science separately, closing with a chapter on modern investigations.

SCHRIFTEN DER DEUTSCHEN AKADEMIE DER LUFTFAHRTFORSCHUNG. Heft 3, 11 pp., .50 rm. Heft 4, 57 pp., 3.10 rm. Heft 5, 72 pp., 4.10 rm. Heft 6, 94 pp., 6 rm. Heft 7, 17 pp., .90 rm. Heft 8, 17 pp., .90 rm. Heft 10, 42 pp., 2.50 rm. R. Oldenbourg, Munich and Berlin, Germany, 1939. Cardboard, 7 × 10 in., illus., diagrams, charts, tables. These pamphlets contain addresses and discussions at meetings of the Academy during 1938 and 1939, as follows: No. 3, on the lowest temperature reached today, by Peter Debye; No. 4, the structure of metals, by Peter Debye, and the application of scientific knowledge to technical problems in the field of metallurgy, by Georg Masing; No. 5, on some dynamic problems of piston engine, by Richard Grammel, and vibrations of the engine-propeller system, by Karl Lürenbaum, also brief report on publications on the question of measuring instruments, by Franz Neugebauer; No. 6, the problem and condition of blind landing, by Paul Frhr. von Handel, and on the goal and results of several years of investigation of the ionosphere, by Hans Blendl; No. 7, on noise propagation by rapidly moving bodies, by Ludwig Prandtl; No. 8, some recent optical investigations, by R. W. Pohl; No. 10, the best physical design of an acoustical altimeter, by Heinrich Hecht, and brief report upon the field of acoustics, by R. W. Pohl, also new optical methods for investigating the reflection of sound producers, by Egon Hiedemann.

SIMPLE AERODYNAMICS AND THE AIRPLANE. By C. C. Carter. Fifth edition. Ronald Press Co., New York, N. Y., 1940. Cloth, 5 1/2 × 8 1/2 in., 510 pp., illus., diagrams, charts, tables, $4.50. This elementary textbook covers airfoil design and criteria for the selection of airfoils, parasite resistance, the propeller, the airplane as a unit, stability and control surfaces, performance, dynamic loads, and aircraft instruments. There are questions and many graphs and diagrams with each chapter, and there are appendixes containing nomenclature, aerodynamic equations, and problems.

STANDARD METAL DIRECTORY, Eighth edition, 1940. Atlas Publishing Co., New York, N. Y., 1939. Cloth, 6 × 9 1/2 in., 610 pp., tables, $10. This directory lists over 11,000 industrial establishments engaged in the manufacture and sale of ferrous and nonferrous materials. Iron and steel plants, ferrous and nonferrous foundries, rolling mills, smelters and refiners of nonferrous metals, dealers in scrap metals, and used pipe are included. The various lists are arranged geographically. The capitalization, officers, plant equipment, capacity, and other data are given in each case. The directory covers the United States and Canada.

STATISTICAL THERMODYNAMICS. By R. H. Fowler and E. A. Guggenheim. The Macmillan Co., New York, N. Y.; University Press, Cambridge (England), 1939. Cloth, 7 × 10 1/2 in., 693 pp., diagrams, charts, tables, $9.50. This version of statistical mechanics for students of physics and chemistry presents the first extensive exposition making full use of all available a priori evaluations of thermodynamic functions. These functions are constructed by the application to particular molecular models of the fundamental theorems of statistical mechanics. The wide scope is indicated by the following list of chapter headings: Introduction; general theorems; permanent perfect gases; crystals; chemical equilibria; grand partition functions; imperfect gases; liquids and solutions; surface layers; electron theory; chemical kinetics; lattice imperfections; electric and magnetic properties.

STORY OF FLYING. By A. Black. McGraw-Hill Book Co., Inc. (Whittlesey House), New York, 1940. Cloth, 6 × 9 1/2 in., 267 pp., illus., $2.75. The history of man's conquest of the air is related from the earliest recorded attempts to the modern airplane, including the balloon, rigid airship, and glider. Air mail and transport are covered, the development of various aircraft parts, instruments, and functions is described, and the final chapter sketches some probable future developments.

1 TABLE of the FIRST TEN POWERS of the INTEGERS from 1 to 1000, Project for the Computation of Mathematical Tables. Works Progress Administration, New York, N. Y., under the sponsorship of the National Bureau of Standards, Washington, D. C., 1939. Paper, 8 1/2 × 14 in., 80 pp., tables, $0.50.

2 TABLES of the EXPONENTIAL FUNCTION e^x. Federal Works Agency, Works Projects Administration for the City of New York, conducted under the sponsorship of the National Bureau of Standards, 1939. Cloth, 8 × 11 in., 535 pp., tables, $2. These publications are the first of a series of mathematical tables being prepared as part of the Works Projects Administration of New York City under the sponsorship of the U. S. Bureau of Standards. The Table of Powers is clearly printed in typescript and is convenient to handle. The Tables of the Exponential Function contain tables of the exponential from −2.5000 to 1.0000 at intervals of 0.0001 to 18 decimals; from 1.0000 to 2.5000 at intervals of 0.0001 to 15 decimals; from 2.500 to 5.000 at intervals of 0.001 to 15 decimals; and from 5.00 to 10.00 at intervals of 0.01 to 12 decimals.

THEORY AND DESIGN OF SPRINGS. By F. M. Cousins. Edwards Brothers, Ann Arbor, Mich., 1940. Cloth, 8 × 11 in., 99 pp., diagrams, charts, tables, $2.50. The more general types of springs, helical, spiral, conical, leaf, ring, and disk, are analyzed for the purpose of establishing a mathematical basis for spring design. Problems connected with the surging characteristics of valve springs and other types subject to dynamic action are investigated. A bibliography is included.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

Technical Program to Supplement Trips at A.S.M.E. Fall Meeting at Spokane

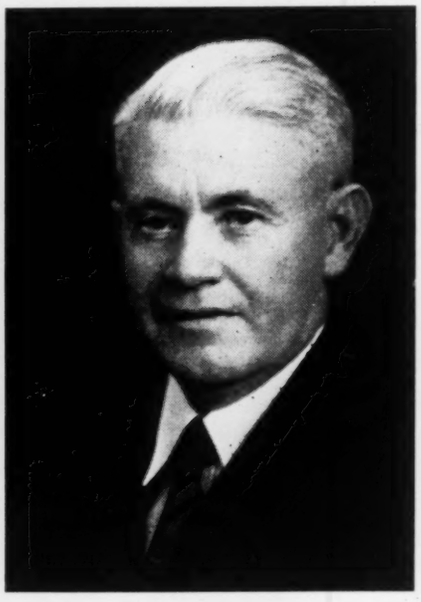
Three Day Meeting, September 3–6, to Have Excellent Papers, Stimulating Speakers, and Unusual Tours

THE A.S.M.E. Inland Empire Section has completed its plans and invites all members of the Society and their friends to take part in the Fall Meeting at Spokane, Wash., Sept. 3 to 6. The headquarters will be at the Davenport Hotel and the complete program including technical sessions, banquets, inspections, and entertainment is of the finest.

The technical sessions cater to a variety of interests and all of the papers may be considered preparatory or supplementary to the arranged inspection trips that have been planned to demonstrate the subject matter presented. Sessions will be held in hydraulics, wood industries, fuels, power, process industries, heat transfer, management, and materials handling. The papers will be of considerable general as well as of technical interest. Highlighting those of general interest are several on design and technical aspects of the Grand Coulee Dam by engineers of the Bureau of Reclamation, and on the uses to which the power may be put in electrometallurgical and other industries.

Banquets and Luncheons

All banquets and luncheons have been arranged to offer a popular appeal and all the speakers have stimulating subjects. At the luncheon on Tuesday noon L. V. Murrow, chief engineer of the Washington Toll Bridge Authority, will speak on the "Lake Washington Pontoon Bridge." On Tuesday evening Major S. E. Hutton and chief engineer F. A. Banks of the Coulee Dam will speak on the "Columbia River Basin Project." These talks on the Coulee Dam are being given preparatory to the inspection trip of the next day. On Thursday noon S. Jenkins of the Potlatch Forests Inc. will talk on "One Hundred Years of Logging in the White Pine Forests of Idaho" and on Thursday evening R. L. Neuberger, the author of "Our Promised Land," will be the speaker.



IN CHARGE OF THE A.S.M.E. FALL MEETING

(H. H. Langdon, left, who is chairman of the Technical Events and E. B. Parker, who is general chairman of the Meeting.)

A Day at Coulee Dam

The convention comes at an opportune time for those interested in seeing Coulee Dam, for it will be possible to see the concrete-pouring operations and also the installation of the massive hydroelectric machinery. On this trip one will also be able to see the gravel plant, the mixing plant, the storage basin, and the Dry Falls that are three times the height of Niagara. An airplane trip over the entire Columbia Basin Project may be arranged. Special consideration will be accorded those at convention. Guide service is being organized.

Variety of Trips Arranged

The last day of the convention is being left open for a variety of inspection trips featuring the largest white-pine mill in the world at Lewiston, Idaho, the Coeur d'Alene mining district with its mines one mile deep, and local plants of interest, including paper plants, pumping plants, and hydroelectric generating plants. Those interested in details connected with the Columbia Basin Project may spend another day at Coulee Dam and adjacent area.

Plan for Spokane!

Combination Vacation Trip and A.S.M.E. Fall Meeting

A special A.S.M.E. tour has been arranged in conjunction with the 1940 Fall Meeting of the Society to be held in Spokane, Wash., Sept. 3–6. The group will leave New York on Aug. 25 and return Sept. 13. Included in the tour are visits to Yellowstone and Teton National Parks, Glacier International Park, and Waterton Lakes Canadian National Park.

Cost of the trip will be $253.55, and up, from Chicago, which includes all expenses except meals in Spokane during the A.S.M.E. Meeting. For a slight additional charge, members of the party may take part in a 50-mile trip around Chicago concluding with dinner at the world-famous Edgewater Beach Hotel.

Complete details may be obtained from A.S.M.E. headquarters, 29 West 39th Street, New York, N. Y. See coupon on page 31 in the advertising section of this issue.

Plan for Spokane!

A.S.M.E. Fall Meeting Program

Spokane, Wash., 3–6, 1940

Headquarters, Hotel Davenport

TUESDAY, SEPT. 3

10:00 a.m.

Hydraulics—I

(Jointly with A.S.C.E. Hydraulic Division)

Hydraulic Problems of the Pulp and Paper Industry, by M. L. Edwards

Some Performance Characteristics of Deep Well Turbine Pumps, by R. G. Folsom

Wood Industries—I

Forest Conditions of the Inland Empire, by Evan W. Kelly

Recent Developments in Woodworking Machinery, by Frederick Nicholson

Heat Transfer

Cooling the Concrete of Grand Coulee Dam, by Clarence Rawhauser

Design and Technical Aspects of a Frozen Earth Dam at Grand Coulee Dam, by Lloyd V. Froage

Calculation of Heat Flow Through Complex Shapes, by R. Weller and F. W. Candee

Fuels—I

Coal Resources of Washington, by Joseph Daniels

Burning Characteristics of Washington Coal in the Domestic Stoker, by H. F. Yancey, K. A. Johnson, and J. B. Cordiner, Jr.

12:30 p.m.

General Luncheon

Lake Washington Pontoon Bridge, by Lacey V. Murrow

2:00 p.m.

Hydraulics—II

Turbines for Grand Coulee Dam, by J. J. Burnard

Testing of Pumps for Grand Coulee Dam, by R. T. Knapp

Wood Industries—II

Recent Developments in Kiln Drying, by Albert Hermann

Research on Dry Kiln Fans, by Arthur D. Hughes

Fuels—II

The Combustion of Waste-Wood Products, by H. W. Beecher and Robert D. Watt

The Effect of the Guffey Bill on Fuel Problems in the Pacific Northwest, by Dave S. Hanley

6:30 p.m.

General Dinner

The Grand Coulee Dam and the Columbia Basin Reclamation Project, by S. E. Hutton

WEDNESDAY, SEPT. 4

Inspection trip to Grand Coulee Dam

THURSDAY, SEPT. 5

9:30 a.m.

Hydraulics—III

Control Gates at Grand Coulee Dam, by P. A. Kinzie

Penstocks for the Grand Coulee Dam, by P. J. Bier

Wood Industries—III

Recent Developments in Preservatives, by Ernest E. Hubert

Redwood Waste and Its Utilization, by C. L. Thompson

Materials Handling—I

Transportation and Handling Equipment for the Placing of Concrete at Grand Coulee Dam, by Ray Fullerton

Redler Method of Handling Materials, by P. R. Hines

12:30 p.m.

Luncheon

One Hundred Years of Logging in the White Pine Forests of Idaho, by Sid Jenkins

2:00 p.m.

Wood Industries and Management

Management and Utilization of Redwood, by Emanuel Fritz

Development of Mechanical Equipment for Manufacturing Fuel Briquettes From Sawmill Wastes, by Robert T. Bowling

Power and Process Industries

The Future of Power Use in the Pacific Northwest, by H. V. Carpenter

Grand Coulee and Electrometallurgical Industries, by A. E. Drucker

Northwest Power and Electro Industries, by W. C. McIndoe

Materials Handling—II

Materials Handling in the World's Largest Pine Saw Mill, by Dave Troy

Materials Handling Methods in Lumber-Working Plants

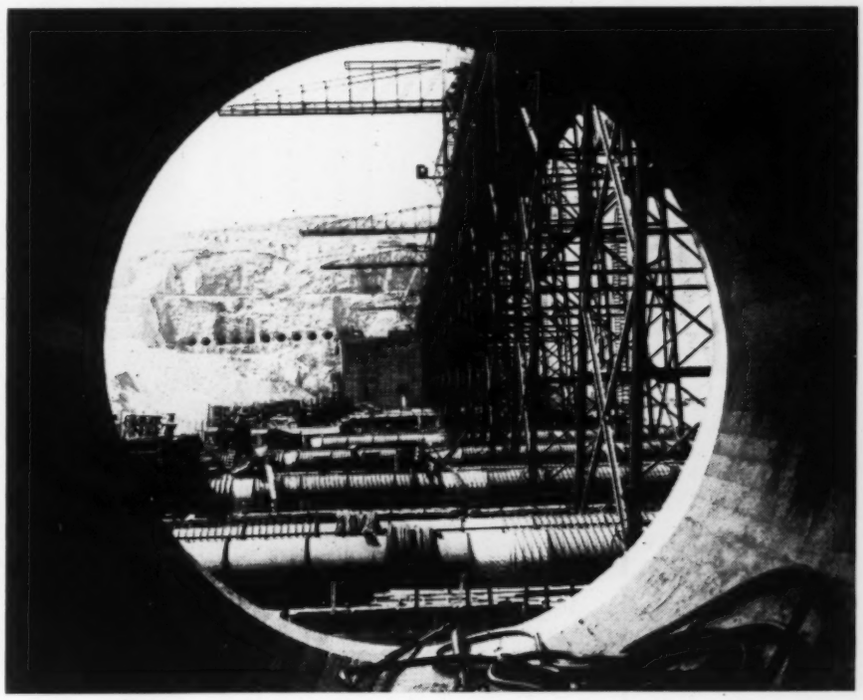
7:00 p.m.

Banquet

Speaker: Richard L. Neuberger

FRIDAY, SEPT. 6

Inspection Trips



GRAND COULEE DAM IN THE COURSE OF CONSTRUCTION

(One of the most interesting trips to be taken during the A.S.M.E. Fall Meeting at Spokane will be that to Grand Coulee Dam.)

A.S.M.E. Council Outlines National Defense Program at 1940 Semi-Annual Meeting Milwaukee, Wis., June 17–20

CONVENING in Milwaukee with the Hotel Pfister as headquarters, June 17–20, 1940, during a week filled with grave fears and concern for the fate of France whose armies were forced to sue for peace, The American Society of Mechanical Engineers, through its Council, passed a set of resolutions which outlined a proposed program of service in the national defense. The total registration of about 650 at this, the 1940 Semi-Annual Meeting of the A.S.M.E., was a tribute to the excellent program of technical papers and plant visits that had been arranged by the Milwaukee committee under the general chairmanship of Fred H. Dorner, and would have been greatly exceeded had it not been for the intense activity in many plants throughout the nation in connection with national defense.

Council Passes Resolutions on National Defense

The national-defense program outlined in the resolution passed by the Council at its meeting on June 16 was presented by Secretary C. E. Davies at the Business Meeting on Monday noon, President Warren H. McBryde in the chair, and was received with enthusiasm and informal expressions of approval by the members present. The resolution, which proposed a nine-point program of service to the nation, was based on the three normal functions of the Society, as Mr. Davies pointed out: (1) To place at the disposal of those who require the skill of the engineer information on the qualifications and experience records of A.S.M.E. members so that the best man may be selected to meet a given need; (2) to provide a public forum for the discussion of problems relating to the national defense; and (3) to make available, in an organized manner, the skills of A.S.M.E. members through review committees and policy-forming groups so that the agencies that are concerned with national defense may have expert advice.

In order to make these three service functions effective, the Council outlined its nine-point program as follows:

1 A pledge of assistance to all agencies concerned with national defense.

2 Expansion of the membership of the A.S.M.E. National Defense Committee, at present consisting of William Carter Dickerman, Kenneth H. Condit, Thos. A. Morgan, and James L. Walsh, to include a dozen or more leaders of American industry who can be made available to aid the program.

3 Offering to the War and Navy Departments the services of a special Committee on Production Engineering to advise on broad policies so that the nation's productive capacity may be increased.

4 Making the Secretary's services available in the aid of national defense.

5 Bringing up to date information on qualifications and experience of members.

6 Participation with the American Society of Civil Engineers in a census of individual consulting engineers and consulting engineering firms who would be available for forwarding any large industrial construction program in connection with the national defense.

7 Encouragement of the A.S.M.E. local sections to hold themselves in readiness to aid in public discussions of defense problems.

8 Encouragement of the A.S.M.E. professional divisions to aid in discussion of the technical phases of defense problems.

9 Encouragement of the Research and Standards Committees to assist in whatever manner possible.

Technical Papers Reflect Varied Interests

The technical program of the 1940 Semi-Annual Meeting opened on Monday, June 17, at 9:30 a.m., with three simultaneous sessions devoted to hydraulics, steam power, and education. Hotel arrangements were such that registration, technical sessions, committee meetings, and luncheons were held on the seventh floor of the hotel; a large room on the floor above provided additional accommodations. Other technical sessions were held on Tuesday, Wednesday, and Thursday mornings, and on Monday evening, and on Monday afternoon, immediately following the Business Meeting, B. J. Vierling, of the Penn Central Airlines, gave an informal talk on engineering and its effect on the advancement of civil aviation.

National meetings of the A.S.M.E. Oil and Gas Power Division and the Applied Mechanics Division were in session at Asbury Park, N. J., and Ann Arbor, Mich., during the Semi-Annual Meeting, and hence these two groups were not represented on the Milwaukee program of technical papers.

At the thirteen technical sessions held at Milwaukee the Hydraulic Division discussed four papers on turbulence, cavitation in centrifugal-pump impellers, measurement of centrifugal-pump efficiency, and economic draft-tube proportions. The Power Division gave its attention principally to steam turbines and steam-turbine blading, with a session on heat-insulation problems and experiences with metals at high temperatures. It also collaborated with the Fuels Division in a session on pulverized-coal firing and the control of gases in the wake of smokestacks. The Fuels Division sponsored a session at which three

Milwaukee Sentinel

GROUP AT A.S.M.E. SEMI-ANNUAL MEETING IN MILWAUKEE

(Left to right: B. J. Vierling, Penn Central Airlines, Detroit, Mich.; Bruno V. E. Nordberg, chairman of the Milwaukee Local Section; Ernest Hartford, assistant secretary A.S.M.E., and Fred H. Dorner, general chairman of the Meeting.)

papers were presented, one on the air-pollution study of the city of Chicago, another on multicyclones, and a third on water-cooled underfeed stokers.

Encouragement and selection of men with creative ability and an employer's views on needed improvements in technical education were discussed at a session of the Committee on Education and Training for the industries. The Management Division listened to a paper that reported studies of power and velocity developed in manual work, and cottonseed processing engaged the attention of the Process Industries Division.

Welding and casting were discussed in two papers presented at one of the Machine Shop Practice Division's sessions, and at the second the subjects were hard facing and a new method of tool and die making. The Railroad Division presented four papers on steam locomotives and valve mechanisms and one (by title) on train acceleration and braking.

Most of the papers presented at Milwaukee were available in preprint form and will appear (or have appeared) in MECHANICAL ENGINEERING or in the Transactions at some future date. The program of the technical sessions appeared in the June issue, page 493.

Milwaukee's Industries Visited

One of the most enjoyable and instructive features of the Milwaukee meeting was the opportunity to visit many of the famous plants of the vicinity. Excellent provisions had been made for planned visits to the Port Washington plant of the Wisconsin Electric Power Company, Monday afternoon; the Nordberg Manufacturing Company, Tuesday afternoon; the Allis-Chalmers Manufacturing Company, Wednesday afternoon, preceded by a luncheon at the plant as guests of the company, at which Max Babb, president of the company, presided and President McBryde spoke; and the Kearney and Trecker Corporation, Thursday afternoon.

In addition to these planned visits, the following plants were available for inspection by individuals or small groups: Milwaukee Filtration Plant, Milwaukee Sewage Disposal Plant, The Falk Corporation, Sivyer Steel Casting Company, Vilter Manufacturing Company, Koehring Company, Chain Belt Company, The Oil Gear Company, The Harnischfeger Company, A. O. Smith Company, Cutler-Hammer Company, Allen-Bradley, and Square D Company.

The Committees

Arrangements at Milwaukee were under the direction of local committees headed by an executive committee of which Fred H. Dorner was general chairman, Hans Dahlstrand and William D. Bliss vice-chairmen, and Bruno V. E. Nordberg, chairman Milwaukee Section A.S.M.E., was honorary chairman. Members of the Committee were: William Monroe White, John D. Ball, Arthur Simon, W. C. Lindemann, Alex H. Luedicke, A. W. Lindstrom, R. C. Newhouse, A. C. Flory, E. C. Schum, L. H. Stark, Fred Dornbrook, F. J. Revere, G. L. Larson, Ben G. Elliott, John Schoen, and George V. Miniberger.

Other committees were as follows:

Honorary Committee, Representatives of Group VI: R. T. Mees, Peoria, Ill., Ralph E. Turner, Chicago, Ill., Norman Bourke, Fort Wayne, Ind., Earl D. Hay, Lawrence, Kansas, W. L. Ducker, Jr., Tulsa, Okla., C. A. Koepke, Minneapolis, Minn., Niles H. Barnard, Lincoln, Neb., G. L. Larson, Madison, Wis., C. C. Wilcox, Notre Dame, Ind., Donald E. Dickey, St. Louis, Mo., and R. A. Cross, Davenport, Iowa.

Subcommittees: Registration and Information, A. W. Lindstrom, chairman, Russell J. Smith, H. E. Rue, Robert C. Strassman, Kenneth D. Sarles, and Charles A. Pofahl; Hotel Committee, Fred H. Dorner, Jr., chairman, Alex H. Luedicke, Rudolph A. Dobrogowski, Theo. F. Eserkaln, John L. Martin, Max Emil Ruess, and Jerome H. Stanek; Program Committee, W. M. White, chairman, William Watson, W. E. Schubert, Harold Falk, and M. K. Drewry; Entertainment Committee, Arthur Simon, chairman, George O. Haglund, and Jerome H. Stanek; Finance Committee, W. C. Lindemann, chairman, Robert Miller, and George V. Miniberger; Women's Committee, Mrs. R. C. Newhouse, chairman, Mrs. Arthur Simon, Mrs. Alex H. Luedicke, Mrs. F. L. Dornbrook, Mrs. Hans Dahlstrand, Mrs. A. C. Flory, Mrs. John D. Ball, Mrs. W. C. Lindemann, Mrs. B. V. E. Nordberg, Mrs. Fred H. Dorner, Mrs. William D. Bliss, and Miss Frances Revere; Reception Committee, E. C. Schum, chairman, Robert J. Cramer, George V. Miniberger, L. V. Schum, Dave McPherson, Walter Saveland, Walter Budny, Jack Dorner, E. V. Andrews, W. J. Thuermann, Ed. Jacobi, Richard E. Boehck, Russell Davis, M. K. Drewry, Eric H. Laabs, H. Erskine Nicol, E. C. Rosenberg, C. W. Kramlich, Thomas M. Jaspar, Harry T. Avey, William Littleton, F. A. Parsons, and W. B. Tucker; Publicity Committee, John D. Ball, chairman, Dolores M. Dereszynski, and Frances Revere; Inspection Trips Committee, L. H. Stark, chairman, E. L. Gates, F. J. Trecker, Paul D. Hess, Robert Miller, G. O. Haglund, George Fratcher, James Brower, and C. S. Lincoln.

Committeemen Get Together

In accordance with A.S.M.E. custom, numerous technical and other committees found opportunity for getting together in connection with the general meeting. The Executive Committee of the Council and the Committee on Local Sections met on Sunday morning, the Council, Sunday afternoon and evening and Monday morning. The Nominating Committee was in session for the benefit of members wishing to place their views before it. Three technical committees and the Board on Technology met on Tuesday afternoon and on Wednesday afternoon the Special Research Committee on Fluid Meters and the executive committee of the Machine Shop Practice Division were in session.

Social Events Center Around Dinner

The first social event of the meeting was the general luncheon on Tuesday noon. Fred H. Dorner, general chairman of the Milwaukee Executive Committee that had charge of the meeting, presided and introduced a number of members of the Council and local committeemen who were seated at the head table. Bruno V. E. Nordberg, chairman, Milwaukee Section A.S.M.E., delivered a brief address of welcome, and B. I. McMinn, of Seattle, Wash., extended an invitation for members to attend the 1940 A.S.M.E. Fall Meeting at Spokane, Wash., Sept. 3–6.

Tuesday evening was given over to a stag party at the Pabst Brewery, which was preceded by a trip through the plant to show the malting, brewing, and bottling processes and the power plant and refrigerating machinery. In the reception room, following the plant trip, motion pictures of the brewing process were shown and a social hour followed, during which beer and pretzels were served.

For the banquet on Thursday night, at which Fred H. Dorner acted as toastmaster, a long head table had been arranged at which were seated members of the A.S.M.E. Council and the local committeemen. Mr. Dorner introduced each of these distinguished persons and paid tribute to his co-workers on the committee and to the industrial plants that had provided opportunities for inspection by the A.S.M.E. members present in Milwaukee. He next introduced Warren H. McBryde, president A.S.M.E., who complimented Milwaukee and expressed the gratification of the Society at the splendid manner in which the visiting engineers and their wives had been entertained. He said that the Society was facing great problems and grave emergencies and that it would not be found wanting in its response to them. He announced that the Fall Meeting would be held at Spokane, Wash., Sept. 3–6, and suggested the slogan "Plan for Spokane."

Members of the "Old Guard" present (an organization of Society members of more than 35 years' standing) entertained as their guests at the dinner representatives of student branches in the vicinity.

Mr. McBryde presented Fifty-Year Membership gold buttons to Frank G. Hobart, of Beloit, Wis., John J. Hoppes, of Springfield, Ohio, and Edward A. Muller, of Cincinnati, Ohio.

Secretary Davies then read the report of the Nominating Committee on officers and members of the Council to be balloted on during the fall, and introduced the candidates who were present. The names of the nominees and brief biographical sketches of their careers will be found on pages 637–640 of this issue.

The Tripoli Temple Chanters of Milwaukee, a chorus of male voices under the direction of Edwin G. Kapplemann, sang a number of songs that were greeted with applause.

Post Speaks on Milwaukee

The address of the evening, "Engineering Romance in Milwaukee," was delivered by George G. Post, vice-president, the Wisconsin Electric Power Company. Mr. Post recalled the familiar slogan "Name it—Milwaukee makes it!" and reminded his audience of the great diversity of basic industries for which the city is famous. He then reviewed briefly the histories of several industrial plants—Evinrude Motor Co., Allis-Chalmers, Bucyrus-Erie, A. O. Smith, Cutler-Hammer, Allen-Bradley, Harley-Davidson, Falk Corporation, Harnischfeger, Nordberg, Chain Belt, Heil Company, Kearney and Trecker, and the Wisconsin Electric Power Company.

The success of these companies, he said, was in a large measure due to the character of the

Photographs Taken at A.S.M.E. Semi-Annual Meeting in Milwaukee During

[(1) Preceding trip through plant, the speakers' table at luncheon with 350 in attendance. (2) At the head table, B. V. E. Nordberg, C. B. Peck, and A. Simon. (3) Walter Geist, L. W. Wallace, W. A. Thompson, W. H. McBryde. (4) B. Schroeder, L. Skog, and two "John Does." (5) Max W. Babb, president Allis-Chalmers, welcomes guests. (6) At head table, A. Iddles, F. H. Prouty, E. W. O'Brien, and W. C. Lindemann. (7) O. W. Boston and Sol Einstein. (8) Applauding Chairman Dorner's address, G. A. Burnham, R. S. Flesheim, C. J. Fechheimer, C. D. Steffans, and S. H. Mortensen. (9) J. A. Roberts and C. S. Lincoln. (10) C. C. Jordan, H. Knecht, R. C. Allen, and F. C. MacKrell discuss modern steam-turbine practice. (11) At the head table, H. A. Thompson, W. H. McBryde, President A.S.M.E., Max W. Babb, F. H. Dorner, general chairman of the meeting, and Harte Cooke. (12) "Oldest A.S.M.E. Member," E. A. Uehling, 91, demonstrates a point to Guy Radley with A. M. Johnson at the right.]

the Luncheon and Inspection Trip at the Allis-Chalmers Company Plant

[(13) H. J. Muth, V. E. Rennix, and H. J. Urbach watch cutting gears in tractor shop. (14) F. C. Ludington explains a mechanism to K. L. Tate. (15) T. C. Knudsen, C. Gorder, L. G. Bird, and G. Heard. (16) Watching molding process on continuous casting machine. (17) Gas-turbine setup is examined by A. Simon, H. S. Dilcher, H. E. Rumpf, G. L. Kollberg, and F. S. Griffin. (18) W. M. White shows design features of section of speed ring. (19) W. H. McBryde, President A.S.M.E., watching, tooling of drive shafts. (20) Looking over the home air-conditioner exhibit. (21) R. R. Slaymaker, F. S. Griffin, W. J. Cope, and F. L. Wilkinson inspect gyratory crusher. (22) G. L. Kollberg describes cylinder of axial compressor to B. V. E. Nordberg and W. C. Lindemann. (23) Another inspection by W. C. Lindemann, H. E. Bergman, Fred Warner, F. G. Hobart, and B. V. E. Nordberg. (24) W. M. White and G. J. Blanton chat. (25) J. D. Greensward, K. L. Tate, J. E. Schoen, and F. C. Ludington.]

engineers in Milwaukee area. They were men of vision, and were ably supported by excellent technicians and expert craftsmen. The women too were to be praised. Pioneering spirit and adherence to the system of free enterprise that submitted to no dictation and asked no subsidies had played its part in the Milwaukee "romance" as had also the cooperation between industry and education as exemplified in the Milwaukee Vocational School, the Boys Technical High School, Marquette University, the Extension Division of the University of Wisconsin, and the Milwaukee School of Engineering.

In conclusion he paid tribute to the recognition on the part of Milwaukee industries of the importance of safety, a movement which had started in that city. As to the future, he pointed out that fundamentals do not change and that it is necessary to understand the fundamental laws on which industry is based. Good workmanship, vision, research, integrity of men, and cooperation with education would be important factors in the future as in the past, and the system of free enterprise must be continued.

The concluding social event of the meeting was a general luncheon on Thursday at which William D. Bliss presided and Hans Dahlstrand spoke.

Women Well Entertained

While the men were attending technical sessions and plant-inspection trips, the women guests were enjoying a special program provided for their entertainment by a committee of which Mrs. R. C. Newhouse was chairman. This program was initiated at a tea and get-acquainted meeting on Monday afternoon. On Tuesday noon there was a luncheon at the Milwaukee Yacht Club, followed by a bridge, and in the evening by a musicale, to which the men were also invited, at the Milwaukee Art Institute, Wednesday morning, at the Public Museum, Dr. Ira A. Edwards gave a talk with illustrations on "Wisconsin, the Indians' Arterial Highway Between the Great Lakes and the Mississippi Valley," which was followed by a tour of the museum. Luncheon was held at the Wisconsin Club, after which there was a sight-seeing drive through the public parks of Milwaukee. Thursday afternoon the women enjoyed a special trip through the plant of the Pabst Brewery.

A.S.M.E. Council Meets in Milwaukee

ON Sunday and Monday, June 16 and 17, during the Semi-Annual Meeting of The American Society of Mechanical Engineers, at Milwaukee, Wis., the Council of the Society held three sessions preceded by a meeting of the Executive Committee of the Council. President Warren H. McBryde presided at all sessions. There were present: A. G. Christie, past-president; W. Lyle Dudley, Alfred Iddles, James W. Parker, and Francis Hodgkinson, vice-presidents; Samuel B. Earle, Frank H. Prouty, Clarke Freeman, Willis R. Woolrich, Joseph W. Eshelman, and Linn Helander, managers; J. J. Swan (Finance), C. B. Peck (Publications), R. L. Sackett (Admissions), Harte Cooke (Professional Divisions), A. J. Kerr and J. N. Landis (Local Sections), H. O. Croft (Relations With Colleges), S. R. Beitler (Constitution and By-Laws), A. R. Mumford (Library), and L. W. Wallace (Research); Robt. C. Strassman (Junior Observer); C. E. Davies, secretary; Wm. M. White and H. E. Degler, guests; C. B. LePage, assistant secretary; and George A. Stetson, editor. At the evening session in addition to most of the foregoing there were present: F. W. Marquis (Local Sections); and A. D. Bailey, C. B. Campbell, P. B. Eaton, R. T. Mees, Knox A. Powell, J. E. Schoen, L. H. Stark, and R. L. Sweigert, guests. At the Monday morning session there were also present: Robt. H. Miller and Walter T. Saveland (Junior Observers); and R. W. Angus, E. W. O'Brien, and T. L. Wilkinson, guests.

Business From Executive Committee

The 1923 employment agreement between the Four Founder Societies was terminated and transferred to the new corporation, Engineering Societies Personnel Service, Inc. (see MECHANICAL ENGINEERING, July, 1940, page 576). A change in the charter of the Engineers' Council for Professional Development was approved whereby the Engineering Institute of Canada becomes one of its participating bodies.

Action taken by the Council at its meeting in Worcester, April 30, 1940, by which the secretary was appointed an observer at the National Conference on Engineering Positions (see MECHANICAL ENGINEERING, July, 1940, page 569), was reconsidered, and the President was authorized to appoint a complete delegation of four representatives to the Conference with the definite understanding that the new body is not organized to enforce any schedule of maximum or minimum salary rates, and with the limitation to the appointees of the Society to the Conference that they will not engage in any such activities on behalf of the Society.

Secretary's Report

On June 4, 1940, the Secretary mailed a memorandum to members of the Council in which he (1) summarized the progress that had been made in developing the work of the Society's divisions, (2) emphasized the importance of the Junior problem, (3) stressed the desirability of recruiting leaders of industry as members or associates of the Society, and (4) called attention to the importance of increasing the funds available for Society use. After extended discussion the Council authorized the President to appoint a committee to study and report to the Council the various methods of increasing the prestige of leadership in the professional divisions, and requested the Committee on Local Sections to appoint a subcommittee of Juniors to analyze the problems of the junior engineer and to report on procedures which should be followed to improve the service of the Society to Junior engineers. The program for enlisting the interest of leaders of industry in the work of the Society was discussed at length, but no action was taken; but in the matter of securing additional funds, the President was authorized to appoint a committee of not more than five members to study means that must be followed to secure financial bequests or gifts.

Research

L. W. Wallace, chairman of the Committee on Research, presented a progress report which the Council accepted with an expression of general approval of its findings. In this report a change in Article B6A, Par. 24, was recommended, and the Council voted to receive this proposed change for action at its next meeting. The proposed by-law is as follows: "The Standing Committee on Research shall advise the Council on the research work of the Society." It was referred to the Committee on Constitution and By-Laws for final consideration.

Mr. Wallace also proposed a procedure whereby selected older members of the Society, who have retired from active engineering work, would be asked to take the leadership in the preparation of comprehensive monographs, work on which would be done by selected junior members. The proposal was approved in principle and the Committee on Research was requested to submit more detailed information on procedure.

Fellow Grade of Membership

Considerable discussion developed over the fellow grade of membership. The Council voted to reconsider its action on this subject taken at its meeting of Dec. 8, 1939, which looked toward a change in the Society's constitution (see MECHANICAL ENGINEERING, January, 1940, page 46). It requested the Committee on Admissions to review and revise, in the light of recent experience and discussion, the specifications for the fellow grade and to report to the Council a suggested interpretation suitable for publication. It also empowered the Committee on Admissions to consult the Local Sections Delegates in preparing the suggested interpretation.

An abbreviated form of application for admission to the fellow grade of men of eminence whose achievements are matters of public record was approved.

R. L. Sackett, chairman of the Committee on Admissions, reported that the Committee had revised the statements of information to references and the membership application blank in order to clear up some misunderstandings. The Committee also asked approval for the appointment of representatives of the Committee in Cleveland, Denver, Providence, and Philadelphia, on a trial basis. These representatives would be expected to interview applicants for admission and transfer and report to the Committee. A trial period of two years was authorized.

Membership Increase

The Committee on Local Sections was requested to prepare a comprehensive plan for increase of membership and to submit it to the Finance Committee and the Executive Committee of the Council. Special attention is to be given to leaders of industry who are not now members of the Society.

National Defense

At the request of the President, the Secretary had prepared a recommendation on steps that may be taken by the Society in rendering service in the present national emergency. The Council voted to adopt the recommendations, subject to such changes as experience and developments might make necessary, and also voted that when, in the opinion of the Executive Committee of the Council it was deemed necessary to bring up to date the records of experience and qualifications of members of the Society, funds should be made available for that purpose. The recommendations adopted are as follows:

1 That the aid of the Society be pledged to all agencies concerned with national defense.

2 That the present National Defense Committee of the Society, consisting of K. H. Condit, W. C. Dickerman, T. A. Morgan, and J. L. Walsh, be expanded by adding about 14 members.

3 That the services of a subcommittee on production engineering, appointed by the President, be offered to the War and Navy departments.

4 That the services of the Secretary be made available in emergency.

5 That data on responsibilities and experience of the members be brought up to date as needed for availability in emergency.

6 That participation with the American Society of Civil Engineers in the census of engineers engaged in construction be approved.

7 That the professional divisions be encouraged to aid by discussions of the engineering phases of the various elements of defense.

8 That the local sections be encouraged to hold themselves in readiness to aid by public discussions of defense problems.

9 That standardization, research, and other project committees be requested to give first attention to matters concerning defense.

American Engineering Council

James W. Parker, member of the joint committee to report and make recommendations on the functions and scope of the American Engineering Council, reported that this committee had its final report in preparation, that the report would be ready shortly, and that it would be submitted to the Council at an early date.

Office Operation

J. N. Landis, chairman of the Committee on Society Office Operation, summarized the report of that committee which stated that the work of the office was up to date and well managed and that the general arrangement and orderliness were excellent. The committee had recommended the addition of one capable technical man to the staff, provision for which was included in the budget for 1940-1941.

Mid-Continent Office

Speaking for a committee that had been asked to study the advisability of continuing the Society's mid-continent office at Tulsa, Okla., J. N. Landis reported that after consultation with the Petroleum Division and the Mid-Continent Section, the committee had come to the conclusion that this office should be abandoned. The Council authorized discontinuance of the mid-continent office.

ESTIMATED BUDGET FOR 1940-1941 ADOPTED BY THE COUNCIL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, JUNE 20, 1940

Activity	Expense under committee supervision	Printing and distribution	Direct office expense	Total
Council	$ 5,500.00	.....	.....	$ 5,500.00
Library	9,266.00	.....	.....	9,266.00
A.E.C.	7,300.00	.....	.....	7,300.00
Finance Committee	250.00	.....	.....	250.00
Nominating Committee	700.00	.....	.....	700.00
Awards	550.00	.....	$ 301.60	851.60
Local Sections	22,918.00	.....	7,485.00	30,403.00
Meetings and Program	5,500.00	.....	4,431.26	9,931.26
Professional Divisions	3,800.00	.....	4,626.26	8,426.26
Admissions	.....	.....	7,476.62	7,476.62
Employment Service	2,645.00	.....	.....	2,645.00
Membership Development	500.00	.....	.....	500.00
Student Branches	10,600.00	$ 6,300.00	4,373.26	21,273.26
Technical committees	1,000.00	.....	19,130.00	20,130.00
Transactions	.....	29,500.00	12,155.00	41,655.00
MECHANICAL ENGINEERING, text	.....	27,000.00	11,635.00	38,635.00
Membership List	.....	4,000.00	.....	4,000.00
60 Year Index	.....	1,000.00	.....	1,000.00
MECHANICAL ENGINEERING, advertising	.....	18,000.00	21,777.65	39,777.65
Mechanical Catalog	.....	21,000.00	17,125.01	38,125.01
Publications for Sale	.....	27,200.00	8,717.34	35,917.34
Retirement Fund	2,700.00	.....	.....	2,700.00
E.C.P.D.	850.00	.....	.....	850.00
General committee expense	100.00	.....	.....	100.00
Professional services	1,150.00	.....	.....	1,150.00
Secretary's office	.....	.....	18,891.00	18,891.00
Accounting	.....	.....	14,275.00	14,275.00
General service	.....	.....	26,110.00	26,110.00
General office expense	.....	.....	16,538.00	16,538.00
Provision for additional staff service for Divisions	.....	.....	4,300.00	4,300.00
	$75,329.00	$134,000.00	$199,348.00	$408,677.00

ESTIMATED INCOME FOR 1940-1941 ADOPTED BY THE COUNCIL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, JUNE 20, 1940

Income	Actual 1938-1939	Budget year 1939-1940	Estimate 1940-1941
Initiation and Promotion Fees (to Surplus)	$ 7,630.10	$ 7,000.00	$ 7,500.00
Membership dues	214,306.03	212,000.00	214,000.00
Student dues	18,193.00	18,200.00	19,800.00
Interest and discount	9,209.59	7,600.00	9,000.00
MECHANICAL ENGINEERING, advertising	71,987.56	74,000.00	74,500.00
Mechanical Catalog, advertising	38,481.76	38,500.00	38,500.00
Publication sales	58,052.63	55,000.00	58,000.00
Miscellaneous sales	1,485.25	1,700.00	1,500.00
Contributions, *Journal of Applied Mechanics*	1,200.00	1,200.00	.....
Engineering Index, Inc.	518.86	519.00	560.00
Registration fees	221.00	296.00	300.00
Sale of securities	.....	.....	.....
Sale of equipment	770.00	125.00	100.00
Membership List advertising	.....	600.00	.....
Total income	$414,425.68	$409,740.00	$416,260.00
To be added to surplus	18,266.86	7,466.15	7,583.00
Balance for expense	$396,158.82	$402,273.85	$408,677.00

Budget for 1940-1941

The budget for 1940-1941, which appears on this page was adopted.

Petroleum Division

The Petroleum Division was authorized to ask the Finance Committee for an allotment of $1500 for one year and was asked to report its plans for the future to the Council at its meeting in December, 1940.

Changes in the By-Laws

It was voted to adopt changes in the By-Laws Articles B7, Pars. 1 and 3; B11, Par. 11; and B14, Pars. 13, 15, and 16. These now read as follows:

Article B7, Election of Directors.

Par. 1 The Regular Nominating Committee of the Society shall consist of eight (8) members with eight (8) alternates elected at the Annual Meeting. The Chairman of the

outgoing Nominating Committee shall serve as an advisory member, without vote, and the Secretary of the outgoing Committee may serve as alternate for him.

Par. 3 For the purpose of nominating members of the Regular Nominating Committee, the Council shall, on or before the first day of October of each year, associate the Local Sections into eight (8) groups, each group to be responsible for nominating one (1) member of the Committee. The Sections which will comprise these groups shall, as far as possible, be contiguous geographically to each other.

Article B11, Local Sections.

Par. 11 There shall be a conference of group representatives each year at the place and at the time of the Annual Meeting of the Society. There shall be sixteen (16) representatives to such annual conference, two (2) from each of the eight (8) groups, which groups shall conform geographically to those provided for in Article B7, Par. 3.

Article B14, Funds.

Par. 13 The Secretary shall report to the Finance Committee each month the total expenditures incurred against each appropriation, together with the amount of each appropriation which is unexpended.

Par. 15 All bills against the Society shall be in charge of the Secretary. Upon competent certification as to correctness and proper authorization, payment shall be made by the Secretary from the Cashier's Account.

Par. 16 The Treasurer shall reimburse the Cashier's Account for payments made therefrom only upon orders duly signed by the Secretary and the Chairman of the Finance Committee.

Group VIII Authorized

The Committee on Local Sections was requested to organize the new Group VIII which will consist of the following sections: Colorado, Kansas City, Mid-Continent, New Orleans, North Texas, and South Texas.

Publications

C. B. Peck, chairman of the Committee on Publications, presented a report on the business aspects of the Society's publications which was accepted with sincere appreciation.

The Council approved the following recommendations of the Committee on Publications relating to changes in policy in issuing the *Journal of Applied Mechanics* and the Transactions:

1 That the *Journal of Applied Mechanics* be issued as an independent publication; (*a*) that it be offered to members at a subscription price of $1 per year; (*b*) that it be offered to nonmembers at a subscription price of $7.50 per year; (*c*) that it be issued six times per year (bimonthly); (*d*) that the financial support under the Transactions budget be $3000; (*e*) that the *Journal* be given a credit of $1 per member and nonmember subscribers; (*f*) that the *Journal* be bound annually with the Transactions; and (*g*) that no credit be allowed for copies of the *Journal* so bound.

2 That Transactions be continued on a bimonthly basis; (*a*) that the saving from reduced support of the *Journal* and other economies be used for publishing more papers in the Transactions; and (*b*) that free copies of preprints of Transactions papers be offered to offset less frequent publication of Transactions.

3 That the foregoing recommendations are contingent on approval of the proposed plan by letter ballot of the members of the Applied Mechanics Division and assurance that approximately 1000 member subscribers can be secured.

4 That, if Division approval is not obtained or if subscription guarantee cannot be promised, the foregoing recommendations are to be withdrawn, in which case the Committee will recommend no change in Transactions or *Journal of Applied Mechanics* procedure.

Upon recommendation of the Committee on Publications, the Council approved a reduction from $10 to $4 in the price of bound volumes of Transactions to members, and a reduction from $2.25 to $2 in the price of bound copies of the Transactions to members who are willing to forego receiving the monthly issues.

A.S.M.E. Applied Mechanics Division Holds Two-Day Meeting at Ann Arbor

University of Michigan and A.S.M.E. Detroit Section Are Hosts

MORE than one hundred members of The American Society of Mechanical Engineers and their guests from twenty states attended the seventh national meeting of the Applied Mechanics Division at Ann Arbor, June 20–21, held under the auspices of the University of Michigan and the Detroit Section of the Society. The University was host, providing living accommodations at Michigan Union and in the university dormitories as well as facilities for the meeting in the amphitheater of the splendidly equipped building of the Horace H. Rackham School of Graduate Studies.

Technical Sessions

Two of the four technical sessions were devoted to the subject of elasticity, one to dynamics, and one to fluid mechanics and thermodynamics. At the opening session under the chairmanship of R. E. Peterson, F. M. Baron gave solutions for the deflection and stresses in elastic slabs as described by influence surfaces, R. D. Mindlin presented H. M. Westergaard's paper on the effects of a change of Poisson's ratio on the stresses, a matter of importance in the interpretation of photoelastic studies of stress distribution, and E. H. Lee discussed the theory of the impact of a mass striking a beam, including the phenomenon of multiple impact.

At the dynamics session under the chairmanship of J. P. Den Hartog, R. P. Kroon presented a paper on the theory of the vibration of turbine blades under impulse excitation, illustrated by numerous experimental demonstrations. The paper led to considerable discussion of the damping characteristics of materials and structures. At the same session Nancy Klock described a computation scheme for harmonic analysis and illustrated its application by means of the torque curve of a two-cycle Diesel engine.

S. Timoshenko presided at the second elasticity session, at which G. H. Lee discussed the influence of hyperbolic notches on the transverse flexure of elastic plates, S. Way presented a group of solutions and analogies in the theory of contact pressure, and H. A. Schade analyzed the problems involved in the design of stiffened plates under lateral loads. Schade's paper gave rise to discussion of the design of ships, in which S. Timoshenko and G. B. Karelitz recalled their experiences in Russia 25 years ago in this field.

At the session on fluid mechanics and thermodynamics under the chairmanship of J. A. Goff, H. L. Dryden presented L. P. Hatch's paper on flow through granular media, R. C. Binder showed and described a chart of the properties of air-vapor mixtures at different pressures, and W. L. DeBaufre outlined his efforts to develop a new equation of state.

Executive Committee Meets

A meeting of the Executive Committee, of the Division, was held on Thursday afternoon at 4 p.m. at which plans were made for participation in the 1940 and 1941 national meetings of the Society.

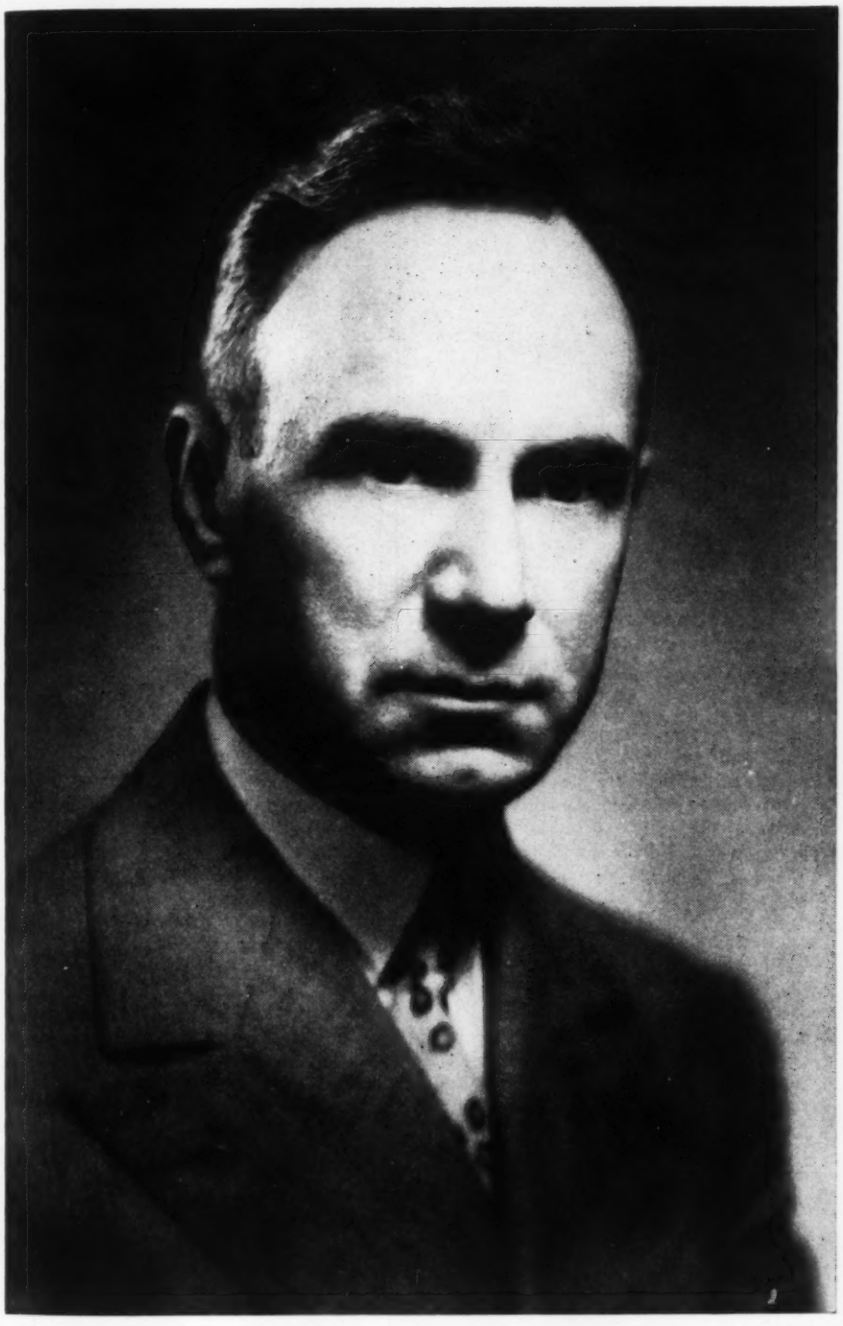
E. L. Eriksen was toastmaster at the dinner at Michigan Union on Thursday evening, June 20. The principal speaker was R. R. McMath, director of the McMath-Hulbert Observatory of the University of Michigan, who showed motion pictures of solar prominences and described the mechanical features of the apparatus for making the pictures. A.S.M.E. headquarters was represented by G. A. Stetson, editor, and G. B. Karelitz of the Standing Committee on Professional Divisions. The chairman of the Applied Mechanics Division J. P. Den Hartog told of the discussions under way with regard to changes in policy of the *Journal of Applied Mechanics*.

The women in attendance were entertained by the wives of the faculty members of the University.

The success of the meeting was due to the hospitality of the University of Michigan and to the work of the local committee, J. Ormondroyd, C. W. Good, E. J. Abbott, E. L. Eriksen, who were assisted by the Detroit Section Executive Committee, the Executive Committee of the Applied Mechanics Division, and headquarters staff.—H. L. DRYDEN.

Feedwater Committee Prepares List of Patents on Subject

SUBCOMMITTEE NO. 9 on Review of the Patent Literature on the Subject of Boiler Water Treatment of the Joint Committee on Boiler Feedwater Studies, of which the A.S.M.E. is a sponsoring organization, has completed its fourth progress report. The report lists important patents issued in this country and in foreign countries for the period from November, 1938, through October, 1939. Mimeographed copies of the report may be obtained from C. B. Le Page at A.S.M.E. Headquarters, 29 West 39th Street, New York, N. Y., at 25 cents a copy.



William A. Hanley

Nominated for President

A.S.M.E. OFFICERS *Nominated for* 1940-1941

DURING the 1940 Semi-Annual Meeting of The American Society of Mechanical Engineers in Milwaukee, Wis., June 17–20, William A. Hanley, director and head of the engineering division, Eli Lilly and Company, Indianapolis, Ind., was nominated by the National Nominating Committee for the office of President of the Society for the year 1940-1941.

Vice-Presidents named by the Committee to serve two-year terms on the Council of the A.S.M.E. were Samuel B. Earle, Clemson, S. C.; Frank H. Prouty, Denver, Colo.; and Edwin B. Ricketts, New York, N. Y.

Managers of the Society to serve on Council for three-year terms included Huber O. Croft, Iowa City, Iowa, Paul B. Eaton, Easton, Pa., and George E. Hulse, New Haven, Conn.

Members of the committee who were in attendance at Milwaukee and made the nominations were: O. A. Leutwiler, Urbana, Ill., chairman, representing Group VI; A. R. Mumford, New York, N. Y., secretary, Group II; E. R. Fish, Hartford, Conn., Group I; D. G. Williams, Allentown, Pa., Group III; K. P. Kammer, New Orleans, La., Group IV; C. M. Gross, Anderson, Ind., Group V; and B. T. McMinn, Seattle, Wash., Group VII.

Election of A.S.M.E. officers for 1941 will be held by letter ballot of the entire membership, closing on Sept. 24, 1940. A ballot will be mailed to every member in good standing about Aug. 12.

Biographical sketches of each of the nominees follow on the suceeding pages:

Nominated for President

William A. Hanley

WILLIAM ANDREW HANLEY, mechanical engineer and business executive, of Indianapolis, Ind., nominated for the office of President of The American Society of Mechanical Engineers for the year 1941, was born in Greencastle, Ind., in 1886. He attended St. Joseph's College, Rensselaer, Ind., for two years and then matriculated at Purdue University, where he received the degree of Bachelor of Science in mechanical engineering in 1911. Twenty-six years later, his alma mater bestowed upon him the honorary degree of Doctor of Engineering.

Prior to attending Purdue University, Mr. Hanley worked five years for the Republic Steel Corporation and the Broderick Boiler Company, both in Muncie, Ind. Immediately after graduation, he entered the employ of Eli Lilly and Company, of Indianapolis, manufacturers of medicinal products. Today he is a director of that company and head of the engineering division. This division designs and supervises all engineering projects, construction, power, maintenance, etc., for the corporation, its branches and subsidiaries, and, in addition, operates certain highly mechanized production departments. In 1938–1939, Mr. Hanley spent much time in Basingstoke, England, building a new manufacturing plant for the British subsidiary of the Lilly company.

Joining the Society in 1913, Mr. Hanley is today a Fellow of the A.S.M.E. Three years after his entrance, he was one of the organizers and the first secretary of the Central Indiana Section. In 1919, the local members elected him chairman of the section. The following year saw the beginning of many years of service by him in the activities and affairs of the parent body with his acceptance of an appointment as one of the A.S.M.E. representatives on the American Engineering Council. During the period from 1922 to 1927, he served on the Committee on Local Sections and, from 1933 to 1938, on the Committee on Relations With Colleges. Starting in 1927, he was elected to a three-year term as manager of the Society and, in 1930, to a two-year term as vice-president. Other A.S.M.E. activities in which he has taken a part include the Special Committee on Junior Participation, Special Committee on Relationship of Society to Accrediting Program, and Committee on Medals.

Over a long period of years Mr. Hanley has contributed to the technical press a number of articles on both engineering and economic subjects. He is a past-president of the Indiana Engineering Council, an honorary member of Tau Beta Pi, a member of the Newcomen Society of England, and a fellow of the American Association for the Advancement of Science. He is also a councilor of the Purdue Research Foundation, a director of the Indianapolis Smoke Abatement League, and a trustee of the Park School of Indianapolis, of the Sigma Phi Epsilon Fraternity (national), and of the Associated Catholic Charities of Indianapolis.

Nominated for Vice-Presidents

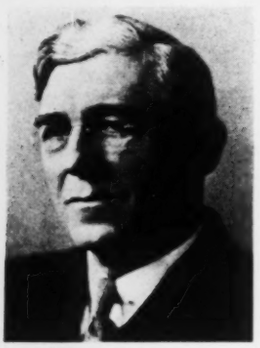
Samuel B. Earle

SAMUEL BROADUS EARLE, engineering educator and research engineer, who has been nominated for the office of Vice-President of The American Society of Mechanical Engineers, was born at Cowensville, S. C., in 1878, and was educated at Furman and Cornell universities.

Dean Earle has been associated with Clemson Agricultural and Mechanical College, Clemson, S. C., since he was graduated from Cornell in 1902. He was assistant professor of mechanical engineering for one year, associate professor from 1903 to 1910, dean of the engineering department and professor of mechanical engineering from 1910 to date, and director of the school's engineering experiment station since 1924. Other duties included supervision of the light and power plant of the College, two pumping stations, and the sewage system. During Dr. Riggs' absence in France in 1919, Dean Earle was acting president of the College and again filled that office from the death of Dr. Riggs in January, 1924, until July, 1925, when the present incumbent, Dr. Enoch Water Sikes, took office. From 1918 to 1920, he was a member of the Public Service Commission of South Carolina and has been consulting engineer for the Apple Valley Orchard and Nursery Company.

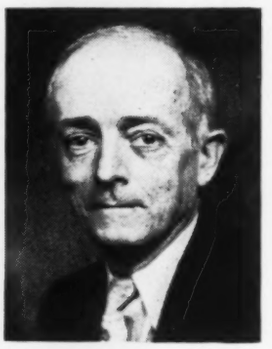
This year, Dean Earle joins the ranks of the Old Guard, having been a member of the A.S.M.E. for thirty-five years, beginning as a junior in 1905, then as an associate in 1908, member in 1914, and Fellow since 1939. He was a member of the executive committee of the Greenville Section from 1923 to 1926, and served as chairman of the section 1925–1926 and 1935–1936. In 1935 and in 1936, he was a delegate from Group IV to the Local Sections Conferences. He was elected manager of the Society for a three-year term in 1937.

In addition to his A.S.M.E. activities, Dean Earle is a member of the Society for the Promotion of Engineering Education, serving as council member from 1927 to 1930, vice-president, 1935–1936, and president, 1937–1938; a member of the South Carolina Society of Engineers, serving as director in 1929 and 1930, and as president in 1933; a member of the American Engineering Council's Committee on Unemployment; and, from 1932 to 1933, as chairman of the engineering section of the Association of Land Grant Colleges and Universities. He is a fellow of the American Association for the Advancement of Science and of the South Carolina Academy of Science, and a member of Tau Beta Pi and Phi Kappa Phi, and the Rotary Club of Anderson, S. C., serving as president, 1933–1934. Furman University conferred upon him the degrees of A.B., A.M., and LL.D. in 1898, 1899, and 1932, respectively, and Cornell University gave him the degree of Mechanical Engineer in 1902.



S. B. EARLE

FRANK H. PROUTY



EDWIN B. RICKETTS

Nominated for Vice-Presidents

Frank H. Prouty

FRANK HARRISON PROUTY, nominee for the office of Vice-President of The American Society of Mechanical Engineers, is a partner in the Prouty Brothers Engineering Company and the Industrial Appraisal Company, both located in Denver, Colo. He was born in that city in 1891, and was graduated from the University of Colorado in 1915 with the degree of Bachelor of Science in civil engineering. The University also conferred upon him the degree of Mechanical Engineer in 1927.

For eight months after graduation, Mr. Prouty was an assistant highway engineer in the U. S. Forest Service. From 1916 to 1918, he designed a boilerhouse, various buildings, and associated structural work for The Colorado Fuel & Iron Co. The next two years were spent at the Lorain, Ohio, plant of the National Tube Company as a special designing engineer in the rolling-mills department, designing and improving mill housings and tables, material-handling devices, engine parts, and buildings. From 1920 to 1924, he was assistant superintendent of the steam and combustion departments at the Cambria plant of the Bethlehem Steel Company, Johnstown, Pa.

Since 1924, Mr. Prouty has been engaged in the practice of consulting engineering at Denver, during which time he has appraised approximately half of the beet-sugar factories in the United States. He was consulting engineer in 1927 for the City of Denver in connection with the reappraisal for tax purposes of all mechanical equipment in that city, has served as consulting engineer for the Public Service Commission of Wyoming on rate cases, has appeared before various courts and commissions in cases involving appraisal of public-utility properties, and, in 1938 and 1939, was consulting engineer for the Federal Government on the appraisal of all utility properties which will be affected by the filling of the Grand Coulee Dam reservoir in the State of Washington. He has appeared several times before the income-tax department of the Bureau of Internal Revenue, Washington, D. C., presenting expert testimony on depreciation.

Mr. Prouty has invented several boilerhouse specialties and also designed a truck-mounted power shovel and numerous boilerhouses and power plants. He has contributed articles to technical periodicals and is a joint author of "Appraisers and Assessors Manual."

He became a member of the Society in 1925, was chairman of the Colorado Section in 1930 and 1931, advisory member to the Committee on Relations With Colleges, and member of the A.S.M.E. Committee on Registration. This year, Mr. Prouty is completing a three-year term as Manager of the Society and member of the Council.

His participation in other engineering and public activities include direction of engineering employment and relief in Colorado from 1930 to 1935; supervision of the Colorado branch of the U. S. Coast and Geodetic Survey in 1933 and 1934 which included the placement of 270 unemployed engineers; heading the engineering vocational-guidance work done by the Colorado Engineering Council in the Denver High Schools; president of the Colorado Society of Engineers in 1934; president of the Colorado Engineering Council in 1937 and 1938; member of the Denver Planning Commission; and member of the Colorado Board of Examiners for Engineers and Land Surveyors.

Edwin B. Ricketts

EDWIN BURNLEY RICKETTS, mechanical engineer with the Consolidated Edison Company of New York, Inc., has been nominated for the office of Vice-President of The American Society of Mechanical Engineers. Born in Brookhaven, Miss., in 1883, he studied at Millsaps College, Jackson, Miss., and received the degree of Bachelor of Science in 1901.

During the fall of 1901, he worked as an assistant chemist with the Baton Rouge Sugar Co. in Louisiana. This was followed by a year as meter tester and switchboard man with the New York Edison Co. in New York City. From 1903 to 1905, he worked as a chemist and engineer for several companies, including Sloss-Sheffield Steel & Iron Co., Birmingham Pipe & Casting Co., and Louisiana Sugar Experiment Station. In 1905, he returned to the New York Edison Co. as assistant chemist, eventually becoming chemist and engineer of tests. Except for the period from 1910 to 1912, Mr. Ricketts has been connected with the New York Edison Company, now the Consolidated Edison Company of New York, Inc. His positions with the company through the years were as follows: Engineer of tests, 1912–1918; assistant to the chief operating engineer, 1918–1927; research engineer, 1927–1936; assistant mechanical engineer, 1936–1938; and mechanical engineer, 1938 to date.

A member of the A.S.M.E. since 1908, he has taken an active part in committee work. From 1926 to date, he has been chairman of the Sectional Committee on Code for Pressure Piping, and a member of its Subcommittee No. 1 on Plan, Scope, and Editing, and, from 1927 to 1937, of its Subcommittee No. 2 on Power Piping. Since 1929, he has been a member of Subcommittee No. 7 on Rating of Piping Fittings of the Standardization Committee on Pipe Flanges and Fittings. Mr. Ricketts has served since 1924 on the Standing Committee on Power Test Codes and on some of its technical committees, such as No. 3 on Fuels, 1926 to date; No. 4 on Stationary Steam Generating Units, 1918–1937; and No. 19 on Instruments and Apparatus, 1921 to date. Beginning in 1925, he served a five-year term on the Special Research Committee on Boiler Furnace Refractories. He represented the A.S.M.E. in 1931–1932 on the N.E.L.A. Pure Air Committee.

Other technical affiliations include membership in the American Society for Testing Materials; National Fire Protection Association; Prime Movers Committee of the N.E.L.A. and Edison Electric Institute, 1920–1938, which he served as chairman for two years, 1927–1928; and the Power Generation Committee of the Association of Edison Illuminating Companies, 1929–1939.

Nominated for Managers

Huber O. Croft

HUBER OGILVIE CROFT, professor of mechanical engineering and head of the department at the University of Iowa, nominated for Manager of The American Society of Mechanical Engineers, was born in Denver, Colo., in 1896. He received a Bachelor of Science degree from the University of Colorado in 1918, and a Master of Science degree from the University of Illinois in 1926.

Immediately upon graduation, he enlisted as a private in the U. S. Air Corps and was stationed at Post Field, Okla. Upon demobilization, he obtained a position as assistant to the chief engineer, Swift & Co., Denver, Colo. This was followed in 1920 as an assistant to Durbin Van Law, member A.S.M.E., and consulting engineer on power plants. In 1922, he was appointed assistant professor of mechanical engineering at the University of Illinois. Professor Croft transferred in 1927 to Stanford University where he became an associate professor of mechanical engineering. In 1929, he accepted his present position as professor of mechanical engineering and head of the department, University of Iowa.

During the summer vacations he has done such work as the preparation of the preliminary designs for the "Civic Center" power plant of the City of St. Louis; experimental research on the design of the Holland Tunnel at the University of Illinois; initial design of the high-pressure gas distributing system of the Public Service Co. of Northern Illinois; and various boiler tests in Illinois, Iowa, Missouri, and Nebraska.

Professor Croft joined the A.S.M.E. in 1920. His activities on behalf of the Society have been his attendance at the 1934 Engineering Conference in Mexico City as A.S.M.E. representative; membership on the Committee on Relations With Colleges, 1935–1940, which he served as chairman in 1940; membership on the Executive Committee of the Fuels Division, 1936–1940, chairman in 1940; Power Test Code Committee No. 21 on Dust Separating Apparatus, 1936 to date; and Committee on Industrial Instruments. Some of his papers published in A.S.M.E. Transactions and MECHANICAL ENGINEERING include "The Calculations of the Dispersion of Flue Dust," "The Engineer and His Societies," and "Encouraging Research in Engineering Education."

Professor Croft is a member of the Committee on Student Selection and Guidance of E.C.P.D. He also holds membership in the American Association for the Advancement of Science, Sigma Chi, Tau Beta Pi, S.P.E.E., Iowa Academy of Science, Theta Tau, Pi Tau Sigma (honorary), Iowa City Chamber of Commerce, Rotary Club of Iowa City (president in 1940), American Society of Naval Engineers, Iowa Engineering Society (president in 1939), and Academy of Political Science. He became a Lieutenant-Commander, E(V)S, U. S. Naval Reserve, in 1936.

(Sketches of nominees continued on p. 640)

HUBER O. CROFT

PAUL B. EATON

GEORGE E. HULSE

Nominated for Managers

Paul B. Eaton

PAUL BURNS EATON, consulting engineer, and professor and head of the mechanical-engineering department at Lafayette College, who is a nominee for Manager of The American Society of Mechanical Engineers, was born in Scranton, Pa., in 1888. He was graduated from Sibley College, Cornell University, 1911, with the degree of Mechanical Engineer.

From 1911 to 1914 and then from 1920 to 1922, he was an instructor in machine design at Cornell University. In 1914, he accepted a position as head of the department of mechanical engineering at the Chinese Government College of Engineering at Tangshan. For his services, he was decorated with the Chinese Order of the Chia Ho. Upon the entrance of the United States into the first World War, he returned to this country and was assigned as an engineer to the technical department of the U. S. Shipping Board, Middle Atlantic District, Baltimore, Md. Upon being relieved from this position, he went back to Cornell University. In 1923, he accepted a position as assistant professor of mechanical engineering at The Pennsylvania State College and, in 1924, went to Lafayette College as an associate professor of mechanical engineering. In 1931, he was promoted to the rank of professor and also became head of the department. Many industrial firms consult him on machine-design and industrial-engineering problems.

Professor Eaton has been a member of the A.S.M.E. since 1922, has served as chairman of the Anthracite-Lehigh Valley Section, was elected delegate to the Local Sections Conferences in 1937 and 1938, serving as speaker at the latter one. He is at the present time a member of the Committee on Relations With Colleges.

He also holds membership in the Society for the Promotion of Engineering Education, American Association of University Professors, Tau Beta Pi, Pi Tau Sigma, Engineers' Club of Lehigh Valley (past-president), Kiwanis Club, Newcomen Society of England, Theta Xi, Easton Symphony Orchestra Association, Easton Musical Arts Chorus, as well as in various regional and state educational organizations.

With Prof. L. J. Bradford, he wrote a textbook, "Machine Design," and he is also author of numerous papers and articles on engineering and educational subjects. Professor Eaton devotes what spare time he has to lecturing on subjects pertaining to education and vocational guidance.

George E. Hulse

GEORGE EGBERT HULSE, mechanical engineer of New Haven, Conn., candidate for the office of Manager of The American Society of Mechanical Engineers, was born in Bellport, N. Y., in 1877. He received his technical education at Pratt Institute Technical High School and the Stevens Institute of Technology, where he was graduated with the degree of Mechanical Engineer in 1902.

His first and only employment has been with his present company, The Safety Car Heating and Lighting Company. He started as an assistant engineer in 1902, advanced to engineer of tests in 1903, and was appointed to his present position as chief engineer in 1907. Mr. Hulse is not only a qualified mechanical engineer but also does considerable electrical-engineering work. He is in charge of design of railway passenger-car lighting apparatus, both gas and electric, lighting aids to navigation, passenger-car heating equipment, refrigeration and heating equipment for freight cars, air-conditioning equipment for passenger cars, and apparatus for destroying insect life in milled cereals.

A member of the A.S.M.E. since 1920 and a Fellow since 1938, Mr. Hulse is now chairman of the Committee on Constitution and By-Laws, was chairman of the New Haven Section in 1934, and represented Group I at the first Local Sections Conference in 1933. He is a past-chairman of the General Committee of Connecticut A.S.M.E. Sections, of which he is the representative on the Connecticut Technical Council.

Other engineering societies in which Mr. Hulse holds membership include the A.I.E.E. and the A.S.R.E.; at present he is president of the A.S.R.E. He is a member of the A.S.A. Sectional Committee on Ball and Roller Bearings, on which he represents the A.S.M.E., and of the A.S.A. Committee on Safety Code for Mechanical Refrigeration.

Jerome Lederer Made U. S. Air Safety Bureau Head

SECRETARY of the Aeronautics Division of The American Society of Mechanical Engineers since 1934, Jerome Lederer, was appointed director of the new Air Safety Bureau of the Department of Commerce on July 1. In accordance with the provisions of President Roosevelt's fourth reorganization plan, the bureau takes over the duties of the independent Air Safety Board which was discontinued.

A.I.E.E. Elects New Officers

NEW officers of the American Institute of Electrical Engineers to be installed Aug. 1, 1940, include R. W. Sorenson, head of the department of electrical engineering, California Institute of Technology, Pasadena, Calif., as president; Everett S. Lee, member A.S.M.E., Joseph W. Barker, member A.S.M.E., K. L. Hansen, J. L. Hamilton, and A. LeRoy Taylor, vice-presidents; and T. F. Barton, M. S. Coover, and R. G. Warner, directors. W. I. Slichter, member A.S.M.E., was re-elected treasurer.

Registration Fee for Non-Members at the 1940 Fall Meeting

There will be a registration fee of $2 for nonmembers attending the 1940 A.S.M.E. Fall Meeting. For nonmembers wishing to attend just one session the fee will be $1. This is in accordance with the ruling of the Standing Committee on Meetings and Program.

Members wishing to bring nonmember guests may avoid this fee by writing to the Secretary of the Society before August 23 asking for a guest-attendance card for the Fall Meeting. The card, upon presentation by a guest, will be accepted in lieu of the registration fee. Guests are limited to *two per member.*

THE SPEAKERS' TABLE, OIL AND GAS POWER CONFERENCE

(Left to right: C. W. Good, L. H. Morrison, F. G. Hechler, Franklin B. Wood, speaker, Oliver F. Allen, toastmaster, E. J. Kates, and M. J. Reed.)

Oil and Gas Power Conference at Asbury Park Attracts 200 Engineers and Guests

Franklin B. Wood of R.E.A. Speaker at Dinner

WITH a registration of 200 members and guests, the Oil and Gas Power Division of The American Society of Mechanical Engineers held its annual Oil and Gas Power Conference at Asbury Park, N. J., June 19–22. The customary exhibit of accessory equipment and products of firms engaged in supplying the trade in this field was held in conjunction with the conference. All technical sessions as well as the exhibition were held at the Hotel Berkeley-Carteret.

Preprinted copies of practically all of the 14 technical papers were available to those attending the conference and in accordance with the practice the Division discussion of these papers will later be mimeographed and the complete proceedings—papers and discussions—will be mailed to those registering at the meeting.

Technical Sessions

The opening session of the afternoon of June 19 was devoted to Diesel fuels and the relation of the Houdry refining process to the economic future of the Diesel engine. At Thursday morning's session two types of shaft couplings were discussed, the hydraulic and the electric slip couplings. The marine Diesel engine was the theme of the Thursday evening session and on Friday morning three papers on design were presented, dealing with stress and deflection of reciprocating parts, engine balance, and frame stiffness and vibration. The combustion gas turbine, characteristics of air cleaners, and the effect of added oxygen on Diesel-engine performance were the subjects of the three papers presented on Friday morning.

In connection with the last-named subject which was in the nature of a preliminary report on experiments conducted at Penn State it was pointed out that these experiments may have considerable effect on the use of Diesel engines for airplanes. The oxygen was added to the engine to increase power momentarily to as much as fifty per cent of rated capacity. If added to a Diesel-engine power plant of an airplane this excess power could be supplied for take-off, after which the engine would assume normal operation. Experiments with this aspect of Diesel-engine operation are still being conducted at Penn State.

The conference closed on Saturday morning with a session on research with two papers, one on the significance of Diesel-exhaust analysis and the other on the effect of variations in atmospheric conditions on Diesel-engine performance.

Exhibition of Equipment Manufacturers

With the attractions of the oceanside location of the hotel, ample opportunity for relaxation was provided, and time was available for inspection trips to Diesel-engine plants in the vicinity. Close proximity of the exhibition to the technical-sessions rooms gave those in attendance ample opportunity to view the equipment and products on display.

Exhibitors at the 1940 Conference were: The Koppers Company, Aluminum Company of America, Bacharach Industrial Instrument Company, Scintilla Magneto Division, Bendix Aviation, The Vellumoid Company, Illinois Testing Laboratory, Inc., Diesel Engine Equipment Corporation, J. H. H. Voss Company, *Diesel Progress*, and Nathan Manufacturing Company.

F. B. Wood, R.E.A., Speaks at Dinner

At the dinner held on Friday evening Colonel O. F. Allen served as toastmaster and Franklin B. Wood, chief of the power and heavy construction section, Rural Electrification Administration, was the speaker. Colonel Allen emphasized the need of additional power for operation of machines required to expedite the national-defense program and discussed the rapid growth of Diesel engines as applied to this field.

Mr. Wood reviewed the development and extension of the Rural Electrification Administration in its efforts to provide electric power

A TABLE AT THE OIL AND GAS POWER CONFERENCE DINNER

(From left to right around the table: F. N. Perry, G. W. Bairlein, Mrs. J. A. Foss, Max Essl, H. A. Boehringer, H. B. Peterson, Frank Oberle, J. A. Foss, T. B. Danckwortt, P. H. Schweitzer, Mrs. Russell Pyles, G. L. Lindsay, Russell Pyles, and Mrs. P. H. Schweitzer.)

for farms not served by public utilities. He reported that of the 7,000,000 farms in the United States nearly 1,700,000 now have electric power mainly through the efforts of the administration of which he is a member. It is of interest that when the administration was organized, $410,000,000 was to be spent for rural electrification in 10 years, or approximately $40,000,000 a year, yet the demand has been so great that Congress made available $140,000,000 last year for the project, and $100,000,000 will be spent in fiscal 1941.

The detailed program of the conference, listing papers and authors, was published in MECHANICAL ENGINEERING for May, 1940, page 420.

Committee Asks Comment on Elevator Safety Code

MANY states and cities throughout the United States have passed laws for the construction, maintenance, and inspection of elevators based upon the American Standard Safety Code for Elevators, Dumbwaiters, and Escalators. The latter was developed under the sponsorship of The American Society of Mechanical Engineers, American Institute of Architects, and the National Bureau of Standards under the procedure of the American Standards Association. From time to time new regulations and ordinances covering elevators are being adopted or old ones extensively revised by the states and municipalities. Since most of these regulations are modifications or adaptations of the rules making up the American Standard Code, it is important that this code be at all times as accurate and as up to date as possible.

The first edition of this code was published in 1921. Since then Sectional Committee A17, organized under the procedure of the American Standards Association, with the assistance of its Subcommittee on Research, Recommendations, and Interpretations, has conducted considerable research and issued three revised editions. The fourth edition (1937) has been well received. However, since its publication the committee's attention has been called to certain rules which seem to require clarification. Further, the advancement of the art has made necessary the revisions of certain of the rules and the addition of new material.

The committee now plans to issue a small pamphlet which will contain the clarifications of obscure passages, the revised rules, and new material in convenient form for the users of the American Standard Code.

While the Subcommittee is constantly receiving criticisms and comments it is probable that its files do not now contain copies of all of the criticisms and comments which have been made on the present edition of the code. It earnestly desires to have before it all possible evidence to the effect that this or that rule should be revised, extended, or eliminated. Accordingly, all persons connected with the manufacture, installation, and use of elevators, both passenger and freight, are urged to send their comments to the Secretary of the Subcommittee, care of The American Society of Mechanical Engineers, 29 West 39th Street, New York, N. Y. Comments should be mailed not later than September 1, 1940.

American Engineering Council

Presents

The News From Washington and Elsewhere

Engineers Aid Defense

THROUGH its professional organizations and individually, engineers in large numbers have hastened to assure the government that they are willing and anxious to do everything within their power to facilitate the program of national defense. A few of the many offers made are:

American Engineering Council through its president, Alonzo J. Hammond, offered all its facilities to the command of the authorities. A White House reply indicated that at the present stage no specific task can be assigned to Council, but that its offer may be accepted in the future.

The American Society of Civil Engineers is sending a questionnaire to all known engineering firms and offices in the United States designed to furnish a ready list of the experience and capacities of engineers, designers, surveyors, and other specialists available for assignment to work connected with the national defense. Cooperating in this endeavor are the American Institute of Architects, American Institute of Mining and Metallurgical Engineers, American Institute of Electrical Engineers, American Institute of Chemical Engineers, American Institute of Consulting Engineers, American Society of Heating and Ventilating Engineers, Society of American Military Engineers, American Society of Refrigerating Engineers, National Society of Professional Engineers, and The A.S.M.E.

The American Society of Mechanical Engineers has adopted a nine-point program (see pp. 630 and 635 of this issue) that includes the offer to the government of the services of a special committee of experts on production problems; the addition of twelve leaders of industry to its national-defense committee; and a general pledge of any other aid that may be requested.

The Society of Automotive Engineers, through its council, has set up a special committee to deal with national defense problems.

The American Society of Agricultural Engineers officially directed its executive council to offer its cooperation with any federal agency concerned with defense problems.

The Illuminating Engineering Society council authorized President Lester H. Garves to proffer its services in any way desired by the government.

The American Institute of Electrical Engineers at its Swampscott meeting took no official action, but sentiment was clear that the organization is willing and eager to cooperate.

The Western Society of Engineers, in a letter by President L. R. Mapes, offered its full cooperation.

The American Society for Metals took similar action in a telegram signed by President James P. Gill.

Individually, many engineers are already actively engaged in promoting the defense program. Among these are A.E.C. president, Alonzo J. Hammond, member of a special advisory committee on construction; Executive Secretary Frederick M. Feiker, appointed to a committee to review inventions in the field of defense, and many other engineers in similar positions.

Rates Based on Net Cost Set for Hydro Plant

ACTING on its first rate case involving a licensed hydroelectric development, the Federal Power Commission has ordered the Safe Harbor Water Power Corporation, of Pennsylvania, to reduce its wholesale power rates so as to provide a net return of not more than 6 per cent on the net investment in its properties, plus adequate working capital, thus upsetting the traditional "fair value" rate base that gives weight, among other things, to estimated reproduction cost. The decision was supported by four of the five commissioners, with the lone dissenter differing, not in principle, but in the belief that a return of only 5½ per cent should be permitted on the net investment.

A.S.M.E. Calendar

of Coming Meetings

September 3–6, 1940
Fall Meeting
Hotel Davenport
Spokane, Wash.

November 7–9, 1940
Joint Meeting of A.S.M.E. Fuels and A.I.M.E. Coal Divisions
Hotel Tutwiler
Birmingham, Ala.

December 2–5, 1940
Annual Meeting
Hotel Astor
New York, N. Y.

April 1–3, 1941
Spring Meeting
Atlanta, Ga.

June 16–20, 1941
Semi-Annual Meeting
Kansas City, Mo.

October 12–15, 1941
Fall Meeting
Louisville, Ky.

(For coming meetings of other organizations see page 20 of the advertising section of this issue)

(A.S.M.E. News continued on page 644)

YOUR *SPECIAL SERVICE* VALVES ARE *REGULARS* IN THE CRANE LINE

THIS NEW CATALOG HELPS YOU CHOOSE

✓ Dependable

✓ Low-Cost

PIPING FOR EVERY CORROSIVE FLUID

NICKEL
NI-RESIST
MONEL METAL
18-8 MO.
EVERDUR
ALL-IRON

NO LONGER need power and processing plants encountering corrosive and other reactive conditions in piping, search for *special* valves and fittings.

Now, a complete range of corrosion-resistant piping equipment is available from stock in the great Crane line. From a wide selection of alloys, you can choose with surety for every condition. There is a Crane material offering highest protective values against chemical impurities for each gas or liquid service.

Crane alloy equipment is not without experience in actual service. Heretofore available on special order only, it has for many years pleased the most exacting users in power and processing industries.

This new Crane line reflects a thorough knowledge of the efficiency of select alloys under varying working conditions. And combining Crane's ability in valve engineering and 85-year manufacturing experience, it assures you of complete satisfaction from every angle.

SEND FOR NEW CATALOG NO. 312

. . . and get acquainted with Crane Corrosion-Resistant Valves and Fittings. You'll find it a reliable piping "headache" remedy and a sound money-saving manual. You will find a lot of use for the authoritative colored "Stop & Go" chart which indicates the degree of suitability of each alloy for specific services. Your Crane Representative will gladly supply this catalog—*free*—or, you may use the coupon below to get one.

CRANE

1940 our 85th YEAR

CRANE CO., GENERAL OFFICES:
836 S. MICHIGAN AVE., CHICAGO
VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

CRANE CO., 836 S. Michigan Ave., Chicago, Ill.
Please send me a copy of your Catalog No. 312. No obligation, of course. ME-8-40

Name.....

Company.....

Address.....

City.....*State*.....

NATION-WIDE SERVICE THROUGH BRANCHES AND WHOLESALERS IN ALL MARKETS

In announcing its decision the Commission points out that the old rate-making principle has been time-consuming, burdensome, and subject to economic shocks. The net investment base, on the other hand, is founded upon established facts "and is not subject to the vagaries of theories, imagination, and abrupt fluctuations of prices and conditions."

The Safe Harbor Company is a wholly owned subsidiary of the Consolidated Gas, Electric Light and Power Company of Baltimore, Md., and the Pennsylvania Water & Power Company, which purchase its entire output.

PWA Starts Liquidation

AFTER seven years of operation in the financing and supervision of construction projects in all parts of the country, the Public Works Administration is now engaged in winding up its affairs under the Congressional mandate that it be completely liquidated by July 1, 1941. Personnel, which reached a peak of 10,400 persons when the last (1938) program was in full swing, is now down to 2331, including over 500 engineers, and further reductions are being made rapidly.

Civil Service Positions

U. S. Civil Service Commission, Washington, D. C.

ENGINEER, assistant to senior grades, $2600 to $4600 a year. Optional branches include heating and ventilating, materials, mechanical, and welding. Closing date is Aug. 5, 1940. Unassembled No. 83, no written examination required.

DRAFTSMAN, aeronautical engineering, assistant to chief grades, $1620 to $2600 a year. Closing date is Aug. 5, 1940. Unassembled No. 82, no written examination required.

INSTRUCTOR, Air Corps Technical School, junior to full grades, $2000 to $3800 a year. Closing date is Aug. 15, 1940. Unassembled No. 62, no written examination required.

Men and Positions Available

Send inquiries to New York Office of Engineering Societies Personnel Service, Inc.

29 W. 39th St. New York, N. Y. | **211 West Wacker Drive Chicago, Ill.** | **57 Post Street San Francisco, Calif.** | **Hotel Statler Detroit, Mich.**

MEN AVAILABLE[1]

MECHANICAL ENGINEER, B.S. (in M.E.) and M.E., 45, married. Seven years' experimental design and research in important manufacturing plants; 15 years' broad teaching experience in colleges. Licensed. Me-499.

MECHANICAL ENGINEERING GRADUATE, 24, single. Three years' experience in rate and production work. Also three summers' experience in railroad-maintenance work. Desires position in railroad maintenance department or industrial production work. Me-500.

MECHANICAL ENGINEER, graduate, 21, single, Scotch-Irish. Desires production experience; shop work, time study, scheduling; ultimate aim factory management. Experience as mechanic's helper in small electrical-manufacturing plant. Me-501.

STEEL PLANT CHIEF ENGINEER. Wide experience in design and construction of all types of steel-plant equipment, especially in flat-rolled products. Good references. Me-502.

MECHANICAL ENGINEER, M.I.T., 1940, S.B., 22. Trained in heat-power, heating, ventilating, air-conditioning. Favor application and sales. Interested also in work with patent law, or involving technical writing. Me-503.

GRADUATE MECHANICAL ENGINEER, 24, single, graduate of recognized university with B.S. (M.E.) degree. Six months' experience, drafting, simple design of sawmill machinery. Fundamental training in thermodynamics and machine shop. Available now. Location immaterial. Me-504-405-D-16 San Francisco.

MECHANICAL ENGINEER, 33, B.S.M.E. Six years with leading heavy-machinery manufacturer, production, assembly, testing, and sales. Desires change to power plant, production, erection, maintenance, or evaluating equipment, specifications, purchasing. Me-505.

1940 MECHANICAL ENGINEERING GRADUATE; three summers' experience in bronze foundry. Interested in design and production of mechanical parts and devices. Willing to begin in shop. Me-506.

GRADUATE MECHANICAL ENGINEER. Service engineer with boiler manufacturer, designing and servicing boilers and related equipment. Purdue 1935 and advanced courses. Available on notice for power-plant, combustion, and allied work. Me-507.

MECHANICAL ENGINEER, 29, graduate, married. Five years' experience in estimates, cost, and specification records. Two years layout drafting. Now employed. Desires production control, cost, or development work with active future. Me-508.

MECHANICAL ENGINEER, B.S.; recent graduate, 22, single, ambitious. Desires placement as trainee on test work or in power-generation field. Will travel. Me-509.

MECHANICAL ENGINEER, 23, single, Stevens 1938. Eight months of shop, inspection, and assembly work. One year drafting. Now employed. Desires development, production, or maintenance work. Me-510.

POSITIONS AVAILABLE

MECHANICAL DESIGNER, under 45, with M.E. degree, must have at least five years' experience in mechanical design and at least one year on pump and pipe layouts for water-supply system; experience in small steam plants desirable. Salary, $270.83 a month. Location, Central America. Y-5464.

PLANT ENGINEER with a number of years' experience in plant maintenance, laying out equipment, and directing the master mechanic in installation of machinery. Must know how to plan and design alterations of machinery, buildings, piping, etc. Salary open. Location New York State. Y-5943.

PUMP DEVELOPMENT ENGINEER, young, graduate mechanical engineer, with sufficient experience in hydraulics to be able to think constructively on pumps and open-minded enough to take instructions and grow with business. Salary open. New England. Y-5945.

ENGINEER with some experience in safety organization work and capable of supervising force field engineers. Pennsylvania. Y-5947.

SALES ENGINEER, about 30, with steel and metallurgy-of-steel experience, for company manufacturing steel roll, tool steel, etc. Man must known steel trade. Salary open. Location, New York, N. Y. Y-5949.

ENGINEER, five to ten years out, with experience in factories on scientific management, preferably the Gantt system. Should be well-versed in motion and time study and have ability along scheduling and planning lines. Location, South. Y-5952.

DEVELOPMENT ENGINEER, 35–45, with experience on electromechanical apparatus. Company manufactures money-collector equipment. Resident of New England preferred. Salary $50 week. Y-5958.

WELDING ENGINEER, 35–45, to act as foreman of sheet-metal and welding department. Must know various types of welding—gas, electric, spot resistance, etc. Man with actual production rather than research experience desired. Will be required to act as supervisor over punch press, shearing, and brake operations; also general line of sheet-metal bench work. Must be of American stock and citizen of United States. Salary open. Location, New England. Y-5960.

DESIGNING DRAFTSMAN familiar high-pressure power-plant piping. Temporary, three–four months. Location, New England. Y-5962.

MACHINE DESIGNER for automatic packaging machinery. Salary open. Connecticut. Y-5963.

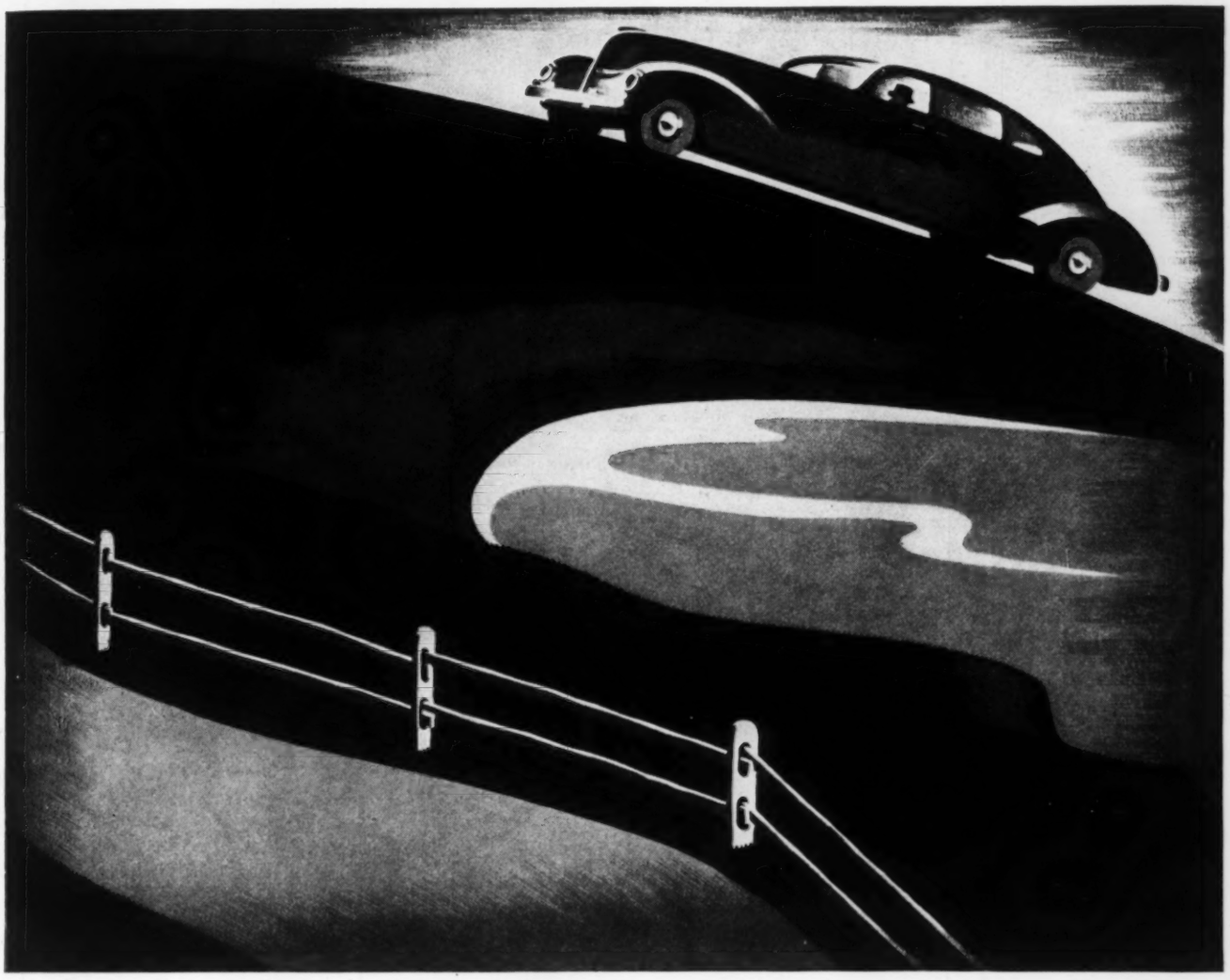
GRADUATE ENGINEER, either mechanical, electrical, or possibly chemical, or physicist, who has specialized in development of factory manufacturing methods, particularly mechanical methods. Salary, $300–$400 monthly. Location, Northern New Jersey. Y-5978.

DEVELOPMENT ENGINEER, 27–32, technical graduate, with few years' experience in domestic-refrigeration industry, for development work on refrigerating unit. Should have sufficient capabilities to direct activities of small group of development and research men. Work will consist of developing and testing of small rotary-type refrigerating units. Salary open. Location, Middle West. Y-5983-C.

DEVELOPMENT ENGINEER, 27–32, technical graduate, with few years' experience in domestic-refrigeration industry, for development

(*A.S.M.E. News continued on page 646*)

[1] All men listed hold some form of A.S.M.E. membership. Where no city is shown after name, man may be reached through New York office.



REQUIREMENTS MET AND MONEY SAVED

Cast iron distributor gears for automotive engines have several recognized advantages. They are quiet, wear well, and are comparatively inexpensive. The problem is to produce a cast iron with the necessary wearing qualities and yet keep it machineable.

Several automotive engine manufacturers are now obtaining the necessary strength (50,000 p.s.i.) and hardness (250-300 B.H.N.) — and eliminating machining difficulties—by making distributor gears of Nickel-Chromium-Molybdenum iron. The machineability of the iron is largely a result of its Molybdenum content.

By specifying this machineable iron, engine builders can meet distributor gear requirements with regard to noise and wearing quality — and save money doing it.

Full technical details concerning Nickel-Chromium-Molybdenum iron, and other cast irons of interest to designers and makers of automotive engines are given in our book "Molybdenum in Cast Iron." Sent free on request to engineers and production executives.

PRODUCERS OF MOLYBDENUM BRIQUETTES, FERRO-MOLYBDENUM, AND CALCIUM MOLYBDATE

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